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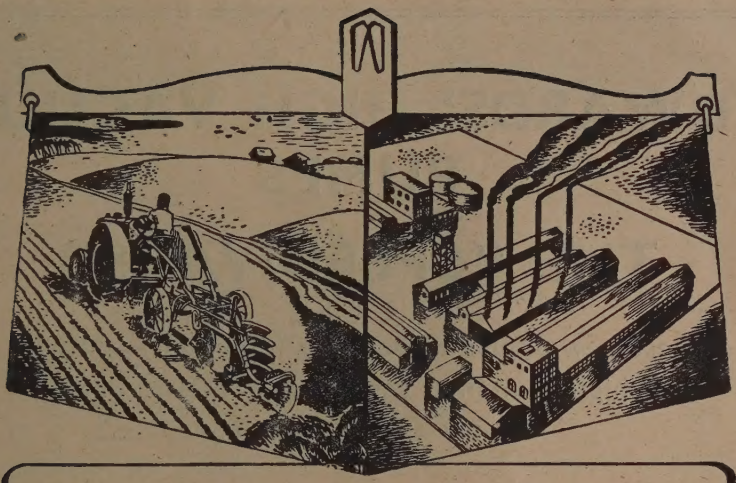

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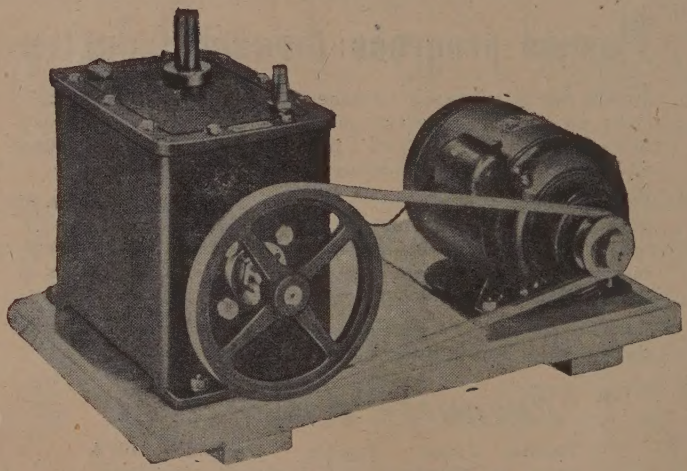

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CONTENTS

	Page
GIVE THE SCIENTIST A CHANCE	285
STUDIES IN INDUSTRIAL ENZYMES	
Part II—Malt Residues as Raw Material for the Production of Fungus Diastase and its application to the Saccharification of Cereals .. .. *A. N. Bindal and M. Sreenivasaya*	287
SURFACE ACTIVE COMPOUNDS	
Part XI—Derivatives of C-Alkylanilines .. .. .. *B. D. Tilak and K. Venkataraman*	290
LETTERS TO THE EDITOR	
Dispersion of Sound Velocity in Organic Liquids by a new Technique .. .. *S. Parathasarathy, A. Pande and M. Pancholy*	299
Application of Chromatography to Explosives .. .. *B. N. Mitra and M. Sreenivasan*	300
Chromatographic Adsorption of Shark Liver Oil on Activated Fuller's Earth .. .. (*Miss*) *Indira M. Gajjar and M. Sreenivasaya*	301
SHARKS AND THE SHARK LIVER OIL INDUSTRY IN INDIA .. *S. B. Setna*	303
ULTRASONICS—THEIR SCIENTIFIC AND INDUSTRIAL APPLICATIONS .. .. *S. Parthasarathy and A. Pande*	308
NOTES AND NEWS	321
SUPPLEMENT:	
Give Science a Chance .. .. *S. S. Bhatnagar*	325
INDIAN PATENTS	332

(For Index to Advertisers, *see* page xii)

Cover Page Illustration :—Graceful common Sharks caught in Indian Waters for Shark Liver Oil (*see* page 303)

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Journal of
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GIVE THE SCIENTIST A CHANCE

THE Presidential Address of Sir S. S. Bhatnagar to the 32nd Session of the Indian Science Congress, which appears elsewhere in this issue, will be read with much interest. It directs public attention to the role of science as an instrument of national welfare and points out that cultivation of science is essential for ensuring an enduring peace in the post-war years. His appeal to the Government and the public to give science a chance is timely. At a time when plans for national development are being seriously considered it is appropriate that the President of the Science Congress should voice the feeling of every scientist in India and point out that science should be given a chance in shaping the things to come. Progress and prosperity in other countries, it should be remembered, have been achieved through the application of science to practical and social ends; economic development in India will be dependent upon the extent to which science will be utilized to develop her abundant resources, both in material and men.

There is little doubt that science is obtaining increasing appreciation in India. In his survey of scientific events of the previous year, Sir S. S. Bhatnagar referred to the visit of Prof. A. V. Hill. "The invitation to Prof. A. V. Hill has been generally taken as an indication of the interest the Government of India are taking in securing the aid of science to problems of national development, to which they are committed during the post-war period." Following the recommendations of Prof. A. V. Hill a separate Department of Planning and Development was created and placed under the charge of Sir Ardeshir Dalal, "a past President of the Indian Science Congress who commands the confidence and respect of the scientists as also of the business community." A Mission of leading Indian scientists is now visiting the United Kingdom, the United States of America and Canada "to observe scientific, industrial and agricultural developments which have come about in these countries during the war and to make recommendations and suggest plans for a further interchange of information and knowledge for mutual help and co-operation." These are notable developments; they are indicative of a serious attempt to assess our needs and plan our universities, industrial and Government laboratories, agricultural, medical and other institutions, to meet national requirements. These problems have been dealt with by Sir S. S. Bhatnagar in his Address.

The public at large are ready enough to accept the practical results of science and even praise science for the material advantages it brings. This is specially true in times of war such as the present, when science receives wide appreciation. This is a valuable gain for science; more, however, is necessary. Progress in a technological era is determined primarily by the developments in science, their quality and extent. The developments must be planned to meet the needs of society

and in the work of planning the scientists should have a place. Men of science, as a rule, lack rhetoric; they are not adept in the technique of capturing the enthusiasm of the public; they occupy a low enough place in the hierarchy of planning committees. If science has to develop, and develop it must, for ensuring national progress, the organization of science must be left to the scientists themselves. They are in a position to determine the direction and extent of development and the needs of scientific institutions. The beneficiaries of science are apt to lay undue stress on applied science, and enthuse over applied research, but the man of science clearly recognizes that if applied science was exclusively encouraged, the basic principles on which new developments depend, would not be elucidated. He realizes that cultivation of science on a wide front, in industrial, agricultural, veterinary, medical and allied fields and in economics and social sciences is essential to ensure a balanced progress. The expansion of scientific personnel required for the universities, technological institutions and industries, and questions relating to equipment and buildings, emoluments for professors and research workers, co-operation in research, pooling of information, purposeful direction in research, and related matters, all present problems which need expert handling. The late Lord Rutherford who presided over the Indian Science Congress seven years ago said, "It is of the highest importance that detailed planning of research should be left in the hands of those who have the requisite specialized knowledge of the problems which required attack. In the British organizations there is no political atmosphere but, of course, the responsibility for allocating the necessary funds ultimately rests with the Government."

Scientific discovery has reached great heights during the past few years. It has not only enabled the development of weapons and instruments essential for success in mechanical warfare but has also aided industry and agriculture in providing the basic needs of humanity. Impressive as these achievements are, it is realized that when devoted wholeheartedly to human welfare, science has in it potentialities of which we do not yet dream. Sir S. S. Bhatnagar points out that the recent achievements "have contributed much to the realization by the common man and the Government that organized science is one of the most important factors in national development. It is a tragedy that a ruthless war and almost universal bloodshed should be necessary for this new awakening, for it should have been obvious without it that science can play and must play an essential part for human advancement. In fact, unless opportunities are provided for science to explore these potentialities for human betterment, a better world cannot be created."

RESEARCH DEVELOPMENT

THE Parliamentary and Scientific Committee, under the chairmanship of Mr. E. W. Salt, on 13th June discussed the establishment of a national research development fund to be administered by an independent group of scientific and business men, for the purpose of pursuing research in directions which may not appeal to particular industries and yet may be vital to the economic progress of the nation.

The idea is that any discoveries should be placed at the disposal of industrial undertakings on a royalty basis, the money so received going to maintain the fund, founded in the first place by a Treasury grant. The proposal was referred to the Parliamentary Action Sub-Committee, which is preparing a report on scientific research generally in order that it may decide whether a specific recommendation is justified. Another and more controversial proposal which was considered by the committee was the introduction of an enabling Bill to give industrial organizations power to make a compulsory levy on their members for research, provided there is a majority of not less than 70 per cent. for such a course. This also was referred to the Parliamentary Action Sub-Committee for further examination. (*C.T.J.*, 1944, 115, 16.)

STUDIES IN INDUSTRIAL ENZYMES

PART II—MALT RESIDUES AS RAW MATERIAL FOR THE PRODUCTION OF FUNGUS DIASTASE AND ITS APPLICATION TO THE SACCHARIFICATION OF CEREALS

By A. N. BINDAL AND M. SREENIVASAYA

(*From the Section of Fermentation Technology, Indian Institute of Science, Bangalore*)

IN a previous communication[1], we have demonstrated the suitability of employing rice and groundnut husks supplemented by groundnut cake, as raw materials for the commercial production of fungus diastase. This work has now been extended to the by-products of the malt and the brewing industries.

During the processing of malt extract and the manufacture of beer from barley or any other cereal, there results a residue, which is utilized either as manure or as a nutritious feed for cattle. The residue consists largely of the husk of the cereal which is associated with the undigested components of the grain to a greater or less extent depending upon the enzymatic potency of the malt. This residue has been found to constitute a rich substratum for the growth of *Aspergillus oryzæ* and other diastase-producing micro-organisms. The resulting moldy residue or the extract therefrom, can be advantageously employed for the direct saccharification of cereals without subjecting them to the usual process of malting.

This direct process has several advantages: (1) it involves no "malting losses" which generally amount to 15 to 20 per cent. on the original weight of the grain. (2) All the carbohydrate of the grain is thus available for the subsequent production of alcohols or acids or compressed yeast as the case may be[2-9]. (3) Since the fungus enzyme extract is, in addition to diastase, associated with a variety of other polysaccharide splitting, protein splitting and ereptic enzymes, the carbohydrate and protein components of the seed undergo a more complete degradation. This circumstance facilitates a rapid and easy filtration of the extract[10]. (4) In contrast with the hydrolytic breakdown and caramelisation of the components brought about by digesting the cereal with a mineral acid at a high temperature, the enzymatic process does not destroy even the most labile vitaminic constituents associated with the seed. In other words, the enzymatic digest of a cereal retains its full vitaminic potency potentially available in the seed, in a free and readily available form. (5) The proteins of the seeds which also get hydrolysed by the enzyme extract are made fully available since none of the essential amino acids are destroyed during the digestion. (6) The nutritive value of an enzymatic digest is higher than the one derived by acid hydrolysis.

While our work was in progress, Fenniksova and Segal published a paper on the utilization of barley residues for the growth of the fungus and the subsequent employment of the moldy mass in the saccharification of cereals[11]. Their investigations are, however, confined to the barley residues, whilst our studies include other cereals like ragi, jowar, bajra, maize and wheat.

Materials and Methods

Barley, ragi, jowar, maize, bajra and wheat, bought in the local bazaar, were separately steeped in running water for 48 hours, when they began to show signs of sprouting. The grains were then allowed to germinate in trays moistened with wet cloth, until the rootlets grew to about two to three-eighths of an inch in length. It took about four to five days to complete the process. The grains were then sun-dried and subsequently kilned in a hot air electric oven, maintained at 90 to 100° C. for 1 hour. Rootlets were removed and the resulting malt powdered to a uniform mesh. The extract was prepared from these samples by digesting the malted powder (100 gms.) with 600 c.c. of water for 5-6 hours at 50° C. The extract was then filtered on a Buchner funnel, the residue pressed and dried in an oven at 90-100° C. This residue was powdered and used as substrate for growing *Aspergillus oryzæ*.

Experimental

A weighed quantity (10 gms.) of each of the above residues was moistened with 15 c.c. of water in a 250 c.c. conical flask. After autoclaving at 20 lbs. for 30 minutes, the residue was inoculated with the spores of

A. oryzæ, obtained from a fortnight-old culture on malt agar. The flasks were then incubated at 30° C. for 4 days. During the period, the flasks were shaken at intervals to facilitate an intimate mixing of the mass. The moldy mass was extracted with 50 c.c. of water and the diastatic activity of the extract determined in Lintner units by the method described in our earlier communication[1]. The results are given in Table I. For comparison, the results of experiments with wheat bran are included.

TABLE I

Residue from	Act/gm.	Total solids per 100 gms.	Total number of units
1. Barley (*Hordeum vulgare*)	16,000	10.80	172,800
2. Ragi (*Eleusine Coracana*)	14,200	11.81	167,702
3. Wheat (*Triticum vulgare*)	14,000	11.82	165,480
4. Maize (*Zea Mays*) ..	13,360	13.44	179,558
5. Bajra (*Pennisetum typhoideum*) ..	12,000	14.26	171,020
6. Jowar (*Andropogan sorghum*)	11,600	14.02	162,632
7. Wheat bran	16,800	9.20	154,560
8. Barley residue + 10 per cent. groundnut cake	17,000	11.90	202,300

It will be seen from the table, that the quantity of diastase (as measured in Lintner units) obtained from 100 gms. of the residue is, in each of the cases, generally higher than the yield from wheat bran. The increases vary between 8 and 16 per cent., the residue from maize giving the highest yield in the series. The purity of the diastase extracts, as revealed by the activity per gram of the preparation, is not of the same standard; there is a slight fall in the purity due to the comparatively high content of sugars and the water soluble forms of nitrogen associated with the residues. The results, however, definitely establish the eminent suitability of these residues as raw materials of considerable economic value in the production of industrial and pharmaceutical diastases.

The diastase-producing capacity of these residues can be appreciably enhanced by an addition of groundnut cake to the extent of 10 per cent. This fact is revealed by the experiments conducted with barley residue which, when supplemented with groundnut cake, yields a higher concentration of the diastatic enzymes (Table I).

Moldy Bran as a Saccharifying Agent for Cereals

In 1914, Takamine demonstrated the exceptional advantages of using moldy wheat bran in the saccharification of cereals[12]. We have already discussed the merits of this direct enzymatic process. We have made a comparative study of the extent of solubilization of various cereals by treating them with a given moldy bran (prepared by growing *Aspergillus oryzæ* N.C.T.C. (India) No. 558, on wheat bran) under carefully chosen and well defined conditions of experiment.

Powdered flour of each of the cereals (10 gms.) was weighed into 250 c.c. conical flasks; water (100 c.c.) was added and the flasks shaken thoroughly. The mixture was gelatinized by autoclaving the material at 20 lbs. for 1 hour. Moldy bran (1 gm.) and 1 c.c. of toluene were added to each of the flasks, the contents intimately mixed and incubated at 50° C. for 12 hours. During this period, practically the entire quantity of starch in the mixture gets saccharified. The digest was filtered on a Buchner funnel, the resulting residue pressed and dried at 90-100° C. in a hot air oven. The diastase-producing capacity of these residues was determined by growing the fungus in the manner described above. The experiments gave very nearly the same results as those obtained for malt residues.

The extracts have been analysed for (*a*) total solids, (b) specific gravity, and (*c*) percentage of soluble extract recovered under the conditions of the experiment described above. The results are given in Table II. For comparison the corresponding figures for malted barley extract are also given.

TABLE II

Analysis of the Digested Extracts

Cereal	Total solids	Specific gravity at 23° C.	Percentage of the solids recovered
Barley	7.60	1,0300	66.90
Ragi	7.57	1,0284	68.90
Wheat	6.79	1,0259	50.94
Jowar	6.23	1,0243	49.23
Maize	7.40	1,0229	57.70
Bajra	7.02	1,0274	54.10
Malted barley ..	6.80	1,0270	59.50

The results (Table II) reveal that in the case of barley, the process of direct enzymatic digestion yields an extract of a higher specific gravity than that possessed by the extract obtained from the malted barley under similar conditions. The merits of this process have already been discussed in an earlier portion of this communication.

Summary and Conclusion

1. Malt residues, the by-products of the malt and brewing industries, have been shown to constitute rich substrates for the production of industrial and pharmaceutical diastases.
2. The diastase-producing capacity of these residues can be enhanced by supplementing them with groundnut cake to the extent of about 10 per cent.
3. The " moldy residue " or the " moldy bran " can be utilized for the direct saccharification of cereals. The residues resulting from this may again be utilized for the production of " moldy residues."
4. The exceptional advantages of the " direct saccharification process " are discussed in detail.

Our grateful thanks are due to the *Council of Scientific and Industrial Research* for their generous financial support in sanctioning a scheme on " Industrial enzymes " of which this work forms a part. We wish to tender our sincere thanks to Professor Sir J. C. Ghosh for his kind interest in the course of these investigations. Our best thanks are also due to Mr. B. N. Sastri who has helped us with many helpful suggestions and fruitful discussion.

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SCIENTISTS AND DEMOCRACY

INAUGURATING the Joint Meeting of the *Indian Academy of Sciences* and the *National Academy of Sciences* on 29th December 1944, at Poona, Dr. M. R. Jayakar said that the principles on which scientists worked and the principles of the working of true democracy were similar. When science came into its own and the more popular the method of teaching science became, the greater would be the chances of establishing democracy in the country.

Dr. Jayakar added new industries had been started by Government under war-time pressure. Scientists had a great part to play in the keeping and the growth of these industries. They had to bring to public use and public benefit, all those great researches and discoveries made during the war.

The function of Science Academies, Dr. Jayakar said, was to protect and develop science in the country, their chief work was to bring out talent in India, which was in plenty but suppressed by adverse circumstances.

Dr. Jayakar referred to the visit of the Indian scientists to England and America. They were India's cultural ambassadors trying to obtain for their country a place of equality and honour in the comity of nations. He welcomed their proposal for establishing a Central Institute, both in England and America, for exchange of students of scientific thought and research; he had no doubt that if the step was taken, it would give a great fillip to the cause of science in India. He welcomed the Government of India's decision to send 500 students to foreign countries for scientific and technical training.

SURFACE ACTIVE COMPOUNDS

PART XI—DERIVATIVES OF C-ALKYLANILINES

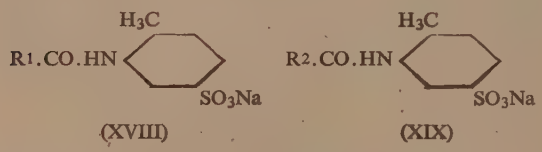
By B. D. TILAK and K. VENKATARAMAN

(*Department of Chemical Technology, University of Bombay*)

THE outstanding properties of lauryl-*p*-toluidide-2-sodium sulphonate (IX)[1,2,3] have led us to synthesise wetting agents by condensing myristic, palmitic and stearic acids and the mixed fatty acids from coconut, cotton seed, groundnut and mowhra oils with *p*-toluidine-2-sulphonic acid, yielding compounds (X), (XI), (XII), (XIV), (XV), (XVI) and (XVII) respectively. Compound (IX), however, could not be improved upon, although the myristic and coconut oil fatty acid compounds exhibited good, all-round properties. The mowhra oil fatty acid compound showed remarkable resistance to hard water as tested by the point light method, and excellent protective colloidal action, and was better in these respects than (IX).

To study the influence of the relative position of the C-alkyl and amino groups lauryl and oleyl chlorides were condensed with *o*-toluidine-4-sulphonic acid to yield (XVIII) and (XIX). Compounds (XVIII) and (XIX) were then compared with the corresponding *p*-toluidide-2-sodium sulphonates prepared earlier[1]. Lauryl-*o*-toluidide-4-sodium sulphonate had better properties in general than the *p*-toluidide-2-sodium sulphonate. The shifting of the C-alkyl group from the *p*- to the *o*-position to the amino group in the oleyl derivatives diminished the protective colloidal action, while the resistance to hard water remained unaltered. The wetting power showed little change as tested by the Herbig number, but it was lower by the Draves test. Lauryl-*o*-toluidide-5-sodium sulphonate (XXI) was inferior to (XVIII) in all properties. The oleyl derivative of *o*-toluidine-5-sulphonic acid (XXII) was less resistant to hard water than (XIX), but both had about the same wetting power. The solubility of these compounds was less than that of (XVIII) and (XIX), in which the sulphonic group was *m*- to the amido group. On comparing (XXI) and (XXII) with the lauryl and oleyl derivatives of *p*-toluidine-3-sulphonic acid described earlier[1], it was found that, in the case of the lauryl compounds, interchanging the positions of the C-alkyl and sulphonic groups gave better wetting agents, but the reverse was true of the oleyl derivatives.

[R^1=$CH_3.(CH_2)_{10}$] [R^2=$CH_3.(CH_2)_7.CH{=}CH.(CH_2)_7$]



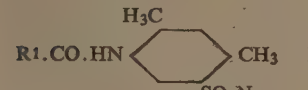
(XVIII) (XIX)

(XXI) (XXII)

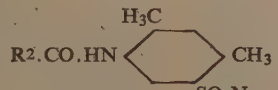
The influence of the introduction of C-alkyl groups in the aromatic ring in lauryl and oleyl derivatives of orthanilic and metanilic acids has been described earlier[1]. The effect of C-alkylation in lauryl and oleyl derivatives of sulphanilic acid was studied by comparing these compounds with lauryl and oleyl *o*-toluidide-5-sodium sulphonate (XXI and XXII). In both the cases the introduction of a C-methyl increased the wetting power, but decreased the resistance to hard water and protective colloidal action. The earlier observation of the favourable influence of the introduction of a C-alkyl group in sodium metanilate with respect to wetting power was confirmed by the superiority of lauryl-*o*-toluidide-4-sodium sulphonate (XIX) to the laurylanilide-*m*-sodium sulphonate (XXXII)[1], but (XIX) was also better in other properties. In sodium N-oleylmetanilate (XXXIII)[1] C-alkylation gave a better wetting agent, but the calcium soap dispersion and the protective colloidal action were decreased.

It appeared, therefore, that C-alkylation in general gave better wetting agents. The solubility of the substituted derivatives was also higher. To observe the influence of increase in the number of the C-alkyl groups in the aromatic ring *m*-4-xylidine-6- and 5-

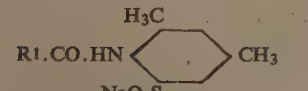
sulphonic acids were condensed with lauric and oleic acid respectively, yielding (XXIV), (XXV), (XXVII) and (XXVIII). Comparing (IX) and (XXIV), it was observed that the



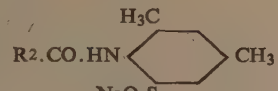
(XXIV)



(XXV)



(XXVII)



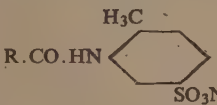
(XXVIII)

introduction of the second C-alkyl group gave an inferior wetting agent, but increased the protective colloidal action and calcium soap dispersion tested by the point light method; the dispersion was less by the titration method. Further, C-alkylation of oleyl-*p*-toluidide-2-sodium sulphonate had an unfavourable influence. Compounds (XXIV) and (XXV) may also be taken as higher alkylated derivatives of lauryl and oleyl-*o*-toluidide-4-sodium sulphonates (compounds VIII and XIV). Considering the lauric acid derivatives, further alkylation decreased the wetting power, as tested by the Herbig number, but by the flotation test the dialkylated derivative was superior; it was also more resistant to hard water as indicated by the titration method, and a better protective colloid. Dialkylation in compound (XIX) gave an inferior product.

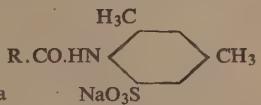
Dialkylation in lauryl and oleyl derivatives of *p*-toluidine-3-sulphonic acids improved the wetting power, but not the other properties.

The effect of further alkylation of the aromatic nucleus was noticed by preparing lauric and oleic acid derivatives of cumidine sulphonic acid (XXX and XXXI). The former had higher wetting power in terms of the Herbig number than the corresponding xylidine compounds at higher concentrations, but the wetting power decreased rapidly with dilution. Examined by the flotation test, it was inferior to either monoalkyl or dialkyl substitution products. It had also less calcium soap dispersing power and protective colloidal action. As against the behaviour of lauryl cumidide sodium sulphonate (XXX), the oleyl analogue (XXXI) gave higher Herbig number in dilute solutions, while at higher concentrations, the mono and dialkylated compounds were more effective. The hard water resistance was improved and the protective colloidal action diminished by introduction of the third alkyl group in the benzene ring.

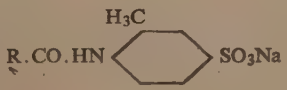
While studying the properties of the whole series of synthetic compounds, it was apparent that in general the lauric acid compounds were better wetting agents as tested by both Herbig number and flotation tests, and were also more efficient with regard to calcium soap dispersing power and protective colloidal action. The preparation of pure lauric acid from coconut oil is relatively expensive, and with a view to preparing wetting agents at cheaper cost, various arylamine sulphonic acids were condensed with coconut oil fatty acids themselves without isolation of the lauric acid.



(XX)

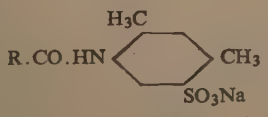


(XXIX)



(XXIII)

R=Fatty acid radical.



(XXVI)

R1.CO.HN.C6H(CH3)3.SO3Na (XXX)

R2.CO.HN.C6H(CH3)3.SO3Na (XXXI)

Thus *o*-toluidine-4- and 5-sulphonic acids, and *m*-4-xylidine-6- and 5-sulphonic acids

were condensed with the acid chloride of the mixed fatty acids of coconut oil (XX, XXIII, XXVI and XXIX). The coconut oil fatty acid compound from *p*-toluidine-2-sulphonic acid has already been described. The new compounds were comparable with lauric acid condensates in wetting power only at higher concentrations, but were less effective in dilute solutions. Their resistance to hard water and protective colloidal action were also less than the lauric acid analogues.

Experimental

The general method of preparation was similar to that described in Part X.

Derivatives of p-toluidine-2-sulphonic acid: Myristyl, palmityl and stearyl chlorides were prepared in the usual manner and condensed with equivalent quantities of *p*-toluidine-2-sulphonic acid. The stearyl and palmityl derivatives were sparingly soluble in most of the solvents, except alcohol. They were, therefore, purified by extracting with hot absolute alcohol. Myristyl-*p*-toluidide-2-sodium sulphonate (X) was brownish in colour (Found : Na, 5.5. $C_{21}H_{34}O_4NSNa$ requires Na, 5.5 per cent.). Palmityl-*p*-toluidide-2-sodium sulphonate (XI) was a yellow, gritty powder (Found : Na, 5.5. $C_{23}H_{38}O_4NSNa$ requires Na, 5.2 per cent.). Stearyl-*p*-toluidide-2-sodium sulphonate (XII) was a reddish yellow, gritty powder (Found : Na, 5.2. $C_{25}H_{42}O_4NSNa$ requires Na, 5.0 per cent.). Fatty acids from coconut, cotton seed, groundnut and mowhra oils had mean molecular weights of 200, 283.5, 282 and 296 respectively. These were converted into acid chlorides, and condensed with *p*-toluidine-2-sulphonic acid. The crude wetting agents were purified by means of absolute alcohol.

Compound (XIV) : condensate from mixed fatty acids of coconut oil (Found : Na, 6.0 ; Calc. Na, 5.9 per cent.).

Compound (XV) : condensate from mixed fatty acids of cotton seed oil (Found : Na, 5.3 ; Calc. Na, 5.0 per cent.).

Compound (XVI) : condensate from mixed fatty acids of groundnut oil (Found : Na, 5.2 ; Calc. Na, 5.0 per cent.).

Compound (XVII) : condensate from mixed fatty acids of mowhra oil (Found : Na, 5.0 ; Calc. Na, 4.7 per cent.).

Lauryl-*o*-toluidide-4-sodium sulphonate (XVIII) and lauryl-*o*-toluidide-5-sodium sulphonate (XXI) : Both the compounds were purified with ethyl acetate. Compound (XVIII) was a cream coloured gritty powder (Found : Na, 5.6 ; S, 8.0). Compound (XXI) was a brown sticky substance (Found : Na, 5.8 ; S, 8.1. $C_{19}H_{30}O_4NSNa$ requires Na, 5.9 ; S, 8.2 per cent.).

Lauryl-*m*-4-xylidide-6-sodium sulphonate (XXIV) and lauryl-*m*-4-xylidide-5-sodium sulphonate (XXVII) : Both the compounds were purified by Soxhlet extraction with ethyl acetate. Compound (XXIV) was a crisp, white powder (Found : Na, 5.5 ; S, 8.1). Compound (XXVII) was a sticky cream coloured substance (Found : Na, 5.8 ; S, 8.0. $C_{20}H_{32}O_4NSNa$ requires Na, 5.7 ; S, 7.9 per cent.).

Lauryl cumidide sodium sulphonate (XXX) : The compound purified from ethyl acetate was a yellowish brown powder (Found : Na, 5.5 ; S, 7.4. $C_{21}H_{34}O_4NSNa$ requires Na, 5.5 ; S, 7.6 per cent.).

Oleyl-*o*-toluidide-4-sodium sulphonate (XIX) and oleyl-*o*-toluidide-5-sodium sulphonate (XXII) : Compound (XIX) was first purified with absolute alcohol and finally by extraction with ethyl acetate in a Soxhlet. It was a brownish sticky substance. Compound (XXII) was also purified from ethyl acetate and was a light brown powder (Found : XIX : Na, 4.8. XXII Na, 5.0. $C_{25}H_{40}O_4NSNa$ requires Na, 4.9 per cent.).

Oleyl-*m*-4-xylidide-6-sodium sulphonate (XXV) and oleyl-*m*-4-xylidide-5-sodium sulphonate (XXVIII) : Compound (XXVIII) was purified by ethyl acetate and (XXV) by dioxan. The former was in the form of a viscous jelly and the latter was a reddish brown hygroscopic powder (Found : XXV : Na, 4.8 ; S, 6.5. XXVIII : Na, 4.6. $C_{26}H_{42}O_4NSNa$ requires Na, 4.7 ; S, 6.6 per cent.).

Oleyl cumidide sodium sulphonate (XXXI) : The substance after purification by Soxhlet extraction with ethyl acetate was obtained as a yellowish brown sticky product (Found : Na, 4.5. $C_{27}H_{44}O_4NSNa$ requires Na, 4.6 per cent.).

Derivatives of Coconut Oil Fatty Acids: Derivatives of *o*-toluidine-4-sulphonic acid (XX) and *o*-toluidine-5-sulphonic acid (XXIII) were purified with ethyl acetate. Compound (XX) was a light brown powder and (XXIII) was a cream coloured powder (Found : XX : Na, 6.1. XXIII : Na, 5.8. Calc. Na, 5.9 per cent.). Derivatives of *m*-4-xylidine-6-sulphonic acid (XXVI) and *m*-4-xylidine-5-sulphonic acid (XXIX). The former was obtained in pure state by extraction with ethyl acetate and the latter with

dioxan compound (XXVI) was a light brown powder and (XXIX) was a dark brown jelly (Found : XXVI : Na, 5.8. XXIX : Na, 5.6. Calc. 5.7 per cent.).

Properties of the Products

Qualitative stability tests :

(*a*) A solution of the wetting agent (2 per cent., 5 c.c.) and caustic soda solution (10 per cent. 5 c.c.) were mixed in the cold and at the boil. All the new compounds gave clear solutions.

(*b*) A solution of the wetting agent (2 per cent., 5 c.c.) was mixed with sulphuric acid (5 per cent. 5 c.c.) and the change noted in the cold and on boiling. Compounds (IX), (X), (XIV), (XVIII), (XXIII) and (XXIV) were stable under both conditions. Compound (XI) gave a turbid solution in the cold, but became clear after boiling. Compounds (XVII), (XXII), (XXV), (XXVI) and (XXXI) were stable in the cold but on boiling gave milky solutions or oily drops. Compounds (XII), (XV), (XVI), (XIX), (XX), (XXI), (XXVII), (XXVIII), (XXIX) and (XXX) decomposed in the cold giving turbid solutions or curdy precipitates.

(*c*) On treating 5 c.c. of a 0.5 per cent. solution of the wetting agent with 5 c.c. of a 1 per cent. solution of calcium chloride (XIII) and (XVII) remained quite clear ; (X), (XIV), (XXII), (XXIII), (XXIV), (XXV), (XXVIII), (XXIX) and (XXX) were slightly turbid, while the others gave curdy precipitates.

Wetting power :

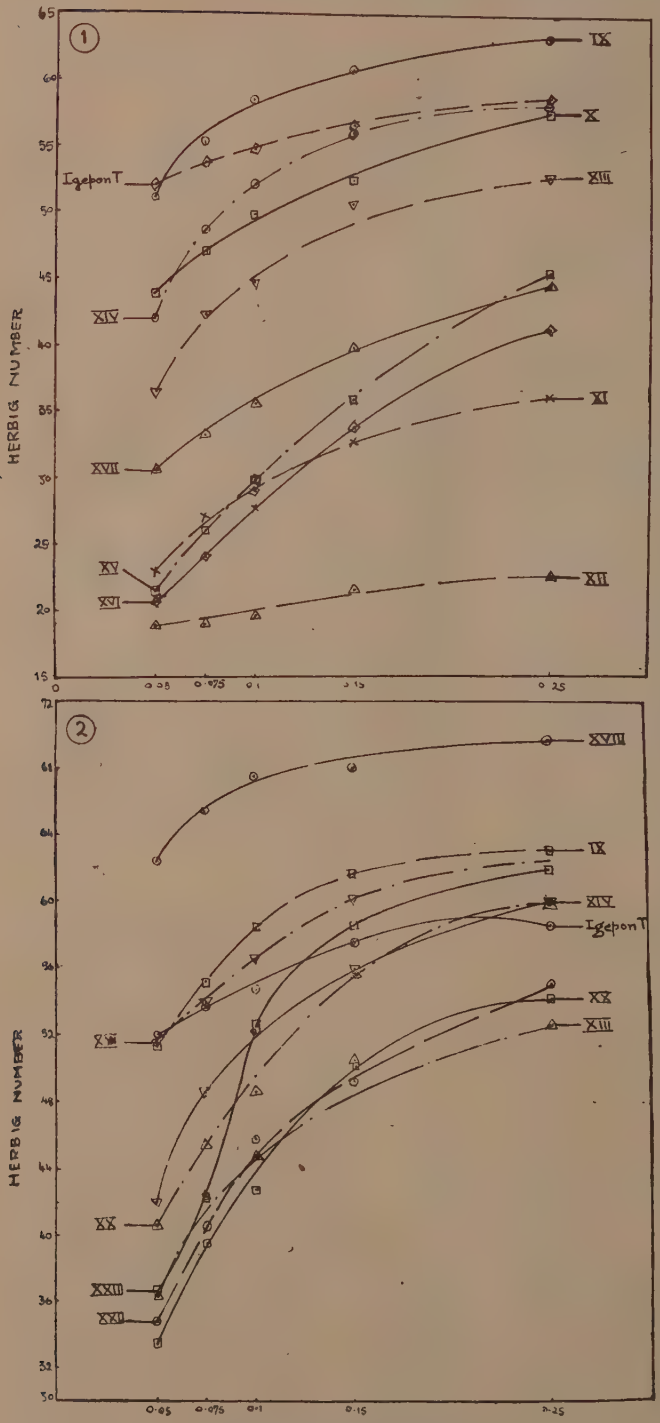
(*a*) Herbig number.—The tests were carried out in the modified Herbig apparatus[4] with 0.25, 0.15, 0.1, 0.075 and 0.05 per cent. solutions of the wetting agents at 30° C. The results are recorded in Table I, and Figs. 1, 2, 3, 4 and 5.

Lauryl-*o*-toluidide-4-sodium sulphonate (XVIII) gave the highest Herbig number at all concentrations. The other wetting agents ranged themselves as follows according to decreasing Herbig number at the stated concentrations : At 0.25 per cent. :—(XXX), (IX), (XXI), (XXVII), (XXIII), (XXIX), (XXXII), (XX), *Igepon T*, (XIV), (X), (XXVI), (XXVIII), (XXII), (XXXIV), (XIX), (XXXI), (XIII), (XXXIII), (XV), (XVII), (XXV), (XVI), (XI), (XII). At 0.15 per cent. : —(IX), (XXI), (XXVII), (XXX), (XXXII), (XXIV), (XXIII), *Igepon T*, (XIV), (XX), (XXVI), (XXIX), (X), (XXVIII), (XXXI), (XIII), (XIX), (XXII), (XXXIII), (XXV), (XVII), (XV), (XVI), (XI), (XII). At 0.1 per cent. :—(IX), (XXVII), (XXI), (XXX), (XXXII), (XXIV), *Igepon T*, (XXIII), (XXXII), (XIV), (XXIX), (X), (XXVI), (XX), (XXVIII), (XXXIII), (XXII), (XXXI), (XIX), (XXV), (XVII), (XVI), (XV), (XI), (XII). At 0.075 per cent. :—(IX), (XXVII), (XXXII), (XXI), *Igepon T*, (XXIV), (XXX), (XIV), (X),

TABLE I

Compound	Herbig number at 30° C. Per cent. concentration of solution					Compound	Herbig number at 30° C. Per cent. concentration of solution				
	0.25	0.15	0.10	0.075	0.05		0.25	0.15	0.10	0.075	0.05
*IX	63.0	61.7	58.4	55.2	51.2	XXII	55.0	49.1	45.7	40.5	34.8
X	57.3	52.3	49.7	46.9	43.8	XXIII	61.8	58.6	52.6	43.3	36.6
XI	35.9	32.6	27.7	27.1	23.0	XXIV	57.2	58.9	55.0	53.7	51.7
XII	22.3	21.6	19.5	18.9	18.8	XXV	41.8	40.2	38.7	37.2	34.1
*XIII	52.5	50.5	44.6	42.2	36.4	XXVI	56.6	54.6	49.4	44.2	40.3
XIV	57.9	55.9	52.1	48.6	42.0	XXVII	62.1	59.9	58.2	54.4	48.5
XV	45.3	35.8	28.9	26.1	21.6	XXVIII	56.2	52.0	48.5	46.1	43.6
XVI	41.2	33.7	29.9	24.0	20.7	XXIX	60.5	53.9	51.4	42.2	41.1
XVII	44.3	39.7	35.5	33.1	30.6	XXX	64.2	59.8	56.5	51.2	46.7
XVIII	69.7	68.0	67.6	65.4	62.0	XXXI	53.5	50.7	45.7	43.6	38.5
XIX	54.1	50.1	42.7	39.5	33.5	*XXXII	60.2	59.0	56.1	54.0	50.9
XX	59.8	55.5	48.6	45.4	40.5	*XXXIII	51.0	49.0	46.7	45.2	41.7
†XXI	62.3	60.1	56.6	53.9	51.5	Igepon T	58.5	56.5	54.7	53.7	52.0

*These compounds have been previously described[1], but are included here for comparison.
†=Determined at 60° C.



Figs. 1 and 2.—Relationship between Herbig number and concentration of the wetting agent. (*See* Table I)

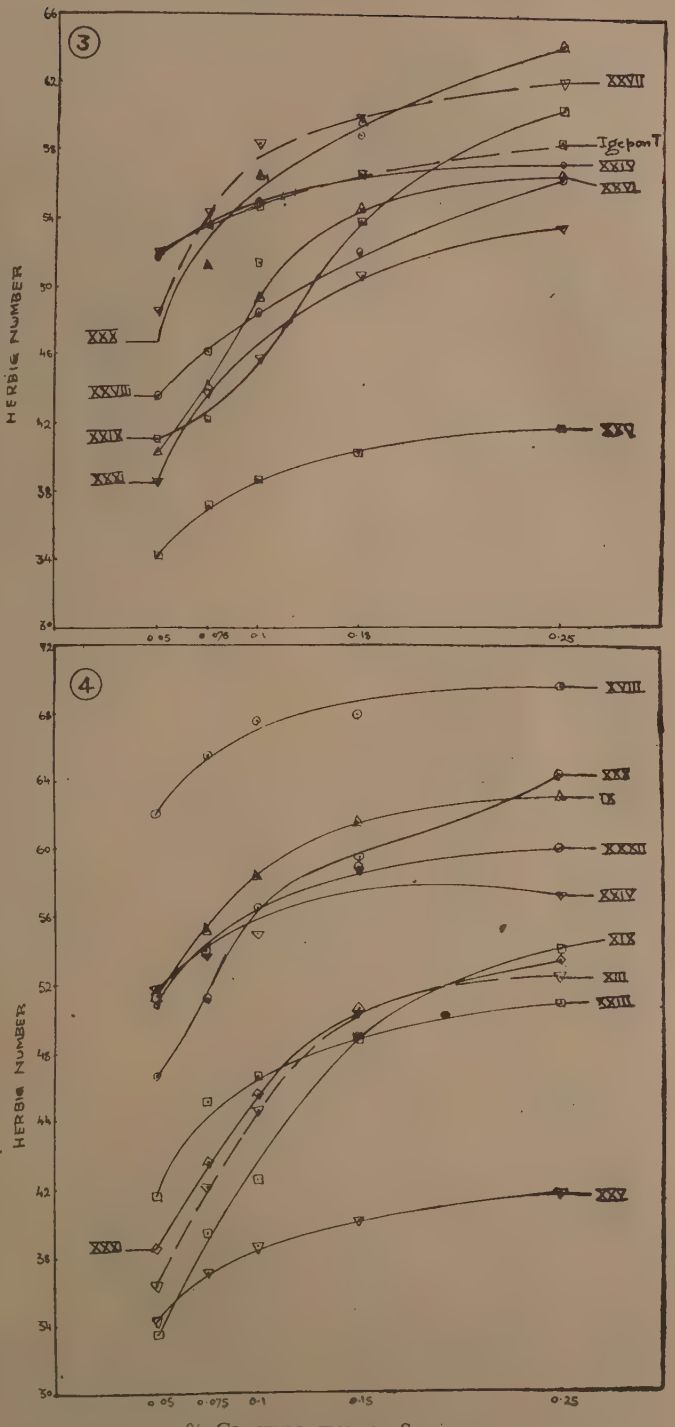
(XXVIII), (XX), (XXXIII), (XXVI), (XXXI), (XXIII), (XXIX), (XIII), (XXII), (XIX), (XXV), (XVII), (XI), (XV), (XVI), (XII). At 0.05 per cent.:—*Igepon T*, (XXIV), (XXI), (IX), (XXXII), (XXVII), (XXX), (X), (XXVIII), (XIV), (XXXIII), (XXIX), (XXI), (XX), (XXVI), (XXXI), (XIII), (XXII), (XXV), (XIX), (XVII), (XI), (XV), (XVI), (XII). Lauryl-*p*-toluidide-2-sodium sulphonate (IX) stood second at concentrations below 0.5, 0.1, and 0.075 per cent., and *Igepon T* second at 0.05 per cent. Lauric acid compounds were consistently superior to the corresponding oleic acid derivatives as judged by the Herbig number (at all concentrations. Thus compounds (IX) (XVIII), (XXI), (XXIV), (XXVII) and (XXX), gave higher Herbig number, than (XIII), (XIX), (XXII), (XXV), (XXIII) and (XXXI) respectively.

Although no definite conclusion could be drawn regarding the influence of the position of the sulphonic group with respect to the amido group in the benzene ring, it was found that in the majority of cases *m*-orientation in the lauric acid compounds gave better wetting agents than *o*-, while in the oleic acid series the *o*-compounds were better wetting agents, confirming the observations made earlier with toluidine sulphonic acids.[1] When lauric acid was condensed with *o*-toluidine-4-sulphonic acid and *o*-toluidine-5-sulphonic acid, the former compound in which the amido and sulphonic groups were in the *m*-position was better as judged by the Herbig number than the *p*-compound, but the oleic acid derivatives exhibited the reverse behaviour.

In comparison with the outstanding qualities of lauryl-*p*-toluidide-2-sodium sulphonate[1], the series of wetting agents prepared by condensing *p*-toluidine-2-sulphonic acid with acid chlorides of saturated fatty acids and with acid chlorides of mixed fatty acids from vegetable oils like coconut, cotton seed, groundnut and mowhra oils, were all less efficient. As the length of the fatty acid chain increased, the Herbig number decreased. Of the compound from mixed fatty acids, that obtained from coconut oil was the best (Fig. 1).

Interchanging the positions of the C-alkyl and sulphonic groups in lauryl derivatives of *p*-toluidine-3-sulphonic acid[1], lauryl-*o*-toluidide-5-sodium sulphonate was found to have higher wetting power. The oleic acid derivatives also behaved similarly. Lauryl-*o*-toluidide-4-sodium sulphonate (XVIII) was a markedly superior wetting agent. The oleyl derivatives of *o*-toluidine-4-sulphonic acid (XIX) also gave a higher Herbig number at higher concentrations than the *p*-toluidine derivatives, although the corresponding derivative from coconut oil fatty acids was less efficient (Fig. 2).

The introduction of C-alkyl groups had a favourable effect on Herbig number only in certain positions. When lauric and oleic acids were condensed with metanilic acid and *p*-toluidine-2-sulphonic acid, compounds containing the C-alkyl group gave a higher Herbig number. When, however, orthanilic acid was condensed with lauric acid, it gave a better wetting agent than the corresponding lauric acid derivative from *p*-toluidine-3-sulphonic acid; while



% Concentration of Solution.

Figs. 3 and 4.—Relationship between Herbig number and concentration of wetting agent. (*See* Table I.)

the oleic acid compound of the latter gave a higher Herbig number. An increase in the number of C-methyl groups, as in lauryl and oleyl-*m*-4-xylidide-6-sodium sulphonates, gave wetting agents inferior to the corresponding metanilic and *p*-toluidine-2-sulphonic acid compounds. The compounds from the mixed fatty acids of coconut oil and *m*-4-xylidine-6-sulphonic acid behaved similarly. As against the superiority of sodium N-laurylorthanilate over lauryl-*p*-toluidide-3-sodium sulphonate, the lauric acid derivative of *m*-4-xylidine-5-sulphonic acid was much better than either of the above compounds. Similarly, oleyl-*m*-4-xylidine-5-sodium sulphonate gave a higher Herbig number than the corresponding orthanilic and *p*-toluidine-3-sulphonic acid compounds. Increasing the C-alkyl groups further, lauryl cumidide sodium sulphonate was a better wetting agent than the dialkyl substituted compound, especially at higher concentrations, but it was inferior to the monoalkyl compound. The oleic acid condensate from cumidine sulphonic acid was, however, better than the corresponding derivatives from metanilic, *p*-toluidine-2-sulphonic and *m*-4-xylidine-6-sulphonic acids (Fig. 3). It appeared from these observations that in lauric acid compounds from metanilic acid, the introduction of one C-alkyl group increased the Herbig number, while further C-methyl groups led to inferior wetting agents. In oleic acid compounds the introduction of C-alkyl groups was advantageous and the Herbig number progressively increased with the number of C-alkyl groups (Fig. 4 and 5). In sodium N-lauryl-orthanilate the

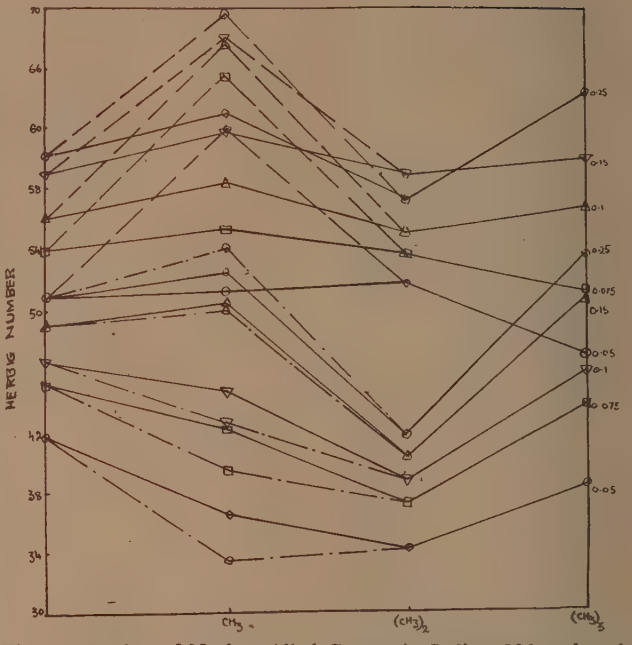


Fig. 5.—Number of Nuclear Alkyl Groups in Sodium N-lauryl and N-oleyl-metanilates

TABLE II

Compound	Time of sinking in sec. at 30° C. Per cent. concentration of solution 0.1	0.05	Compound	Time of sinking in sec. at 30° C. Per cent. concentration of solution 0.1	0.05
IX	6	22	XXI	21	> 180
X	32	96	XXII	79	180
XI	120	> 180	XXIII	39	> 180
XII	> 180	> 180	XXIV	8	19
XIII	12	28	XXV	93	> 180
XIV	23	71	XXVI	35	110
XV	> 180	> 180	XXVII	7	18
XVI	> 180	> 180	XXVIII	26	64
XVII	96	175	XXIX	33	83
XVIII	10	22	XXX	41	> 180
XIX	31	142	XXXI	42	84
XX	36	80	*Igepon T*	20	42

introduction of a C-methyl group gave a poorer wetting agent, but a further substitution of C-alkyl groups was advantageous.

(*b*) Time of sinking.—The results obtained by the Draves test[5] with 0.1 and 0.05 per cent. solutions of the wetting agents at 30° C. are recorded in Table II.

The values obtained were not in the same order as the Herbig numbers at these concentrations.

Compound (XVIII) which gave the highest Herbig number at 0.1 and 0.05 per cent. concentrations was only fourth in order judged by the time of sinking. Compound (IX) was the best at 0.1 per cent. concentration, while (XXVII) was the best at 0.05 per cent. concentration.

In the derivatives from *p*-toluidine-2-sulphonic acid, the lauric acid derivative (IX) was the best, and in the mixed fatty acid products, the coconut oil fatty acid compound was the best, although it was inferior to the lauryl compound. The compounds in which the amido and sulphonic groups were *o*- to each other were consistently superior to the *m*-isomers and in the derivatives of *o*-toluidine-4- and 5-sulphonic acid, those compounds in which the amido and sulphonic acid groups were in the *m*-position were better wetting agents as shown by the sinking time.

Mono-C-alkyl substitution in the majority of cases gave better wetting agents. Lauryl cumidide sodium sulphonate (XXX) and lauryl-*p*-toluidide-3-sodium sulphonate at 0.1 per cent. concentration were exceptions. The introduction of further C-alkyl groups increased the wetting power in some cases, while in others it was reduced.

All the lauric acid compounds were superior to the corresponding oleic acid derivatives.

At 0.1 per cent. concentration (XIX) was as good and (XXVII), (XXIV), (XVIII), (XXXII) and (XXII) definitely better than *Igepon T*, although except for (XXVII), (XVIII) and (XXIV), *Igepon T* gave a higher Herbig number than the other compounds at 0.1 per cent. concentration. At 0.05 per cent. concentration all the above compounds except (XXXII) were again better than *Igepon T*, whereas the latter ranked second in regard to Herbig number.

(*c*) Calcium soap dispersing power

(*a*) *Titration method*[6] : To 20 c.c. of the soap solution, 5 c.c. of 1 per cent. auxiliary agent solution were added, followed by 25 c.c. of calcium chloride solution, and the net values of the titre obtained are recorded in Table III.

TABLE III

Compound	Net dispersion: Auxiliary agent solution used 5 c.c. of 1 per cent.	Point light method: Per cent. concentration of calcium chloride solution	Congo Rubine Number: Amount of auxiliary agent in mgm.
IX ..	12.3	0.321	8.75
X ..	6.6	0.276	30.0
XI ..	7.0	0.620	37.0
XII ..	5.5	0.290	110.0
XIII ..	6.6 (5 c.c. of 2 per cent. wetting agent used	0.115	6.25
XIV ..	6.1	0.310	Even 130 mg. insufficient
XV ..	0.0	0.160	„
XVI ..	0.34	0.140	120.0
XVII ..	8.6	0.640	6.0
XVIII ..	10.0	0.680	6.0
XIX ..	4.9	0.260	130.0
XX ..	1.85	0.145	60.5
XXI ..	1.3	0.218	47.5
XXII ..	0.3	0.206	27.5
XXIII ..	2.4	0.157	75.4
XXIV ..	11.7	0.546	3.5
XXV ..	3.0	0.244	30.1
XXVI ..	2.7	0.194	50.0
XXVII ..	2.6	0.170	8.0
XXVIII ..	0.7	0.194	85.0
XXIX ..	1.0	0.230	50.0
XXX ..	6.7	0.145	40.0
XXXI ..	5.9	0.285	45.0
Igepon T .	12.5	0.319	12.9

Lauric acid compounds were invariably better than the oleic acid analogues. Both in the xylidides and the *o*-toluidides, *m*-orientation of the amido and sulphonic groups was favourable. C-alkylation in the benzene ring in lauryl and oleyl derivatives of metanilic and orthanilic acid gave compounds less resistant to hard water. Amongst the derivatives of *p*-toluidine-2-sulphonic acids other than the lauric acid compound, the product from mowhra oil fatty acids had the highest resistance to hard water and the coconut oil fatty acid derivative was next in order.

(*b*) *Point light method*[6].—The strengths of calcium chloride solution which rendered the point light just invisible are recorded in Table III.

The values obtained were in some cases widely divergent by the two methods, but

the lauric acid compounds were again superior to the oleic acid analogues. Introduction of C-alkyl groups did not change the dispersing power substantially, but with two C-alkyl groups as in the xylidides, it was increased as shown by the point light method. Further C-alkyl groups as in the cumidides were undesirable.

Congo Rubine number[7].—The amount of auxiliary agent in mgms. just sufficient to prevent the colour change is recorded in Table III. Compound (XXIV) gave the lowest figure and (XVII), (XXVII) and (XVIII) were also found to have higher protective colloidal action than *Igepon I*. In the majority of cases lauric acid compounds were better than the oleyl derivatives. In the lauric acid derivatives of metanilic and orthanilic acid introduction of C-alkyl groups gave better protective colloids, but not in the oleic acid series. As the number of C-alkyl groups in lauryl anilide-*m*-sodium sulphonate was increased, the protective colloidal action increased upto two alkyl groups and decreased with a third. Among orthanilic acid derivatives, the toluidide was the best. Among the derivatives of *p*-toluidine-2-sulphonic acid the mowhra oil fatty acid compound (XVII) had the highest protective colloidal action.

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A NATIONAL INSTITUTE OF ECONOMIC RESEARCH

IN his inaugural address delivered at the 27th session of the *Indian Economic Conference*, the Hon'ble Sir Ardeshir Dalal, Member for Planning and Development, stressed the importance of understanding the economic aspects of the community's life, and expressed the opinion that the jealousies, strife and discord which are hampering India's progress can ultimately be traced to the same economic roots. He went on to say that only by intelligent planning of the economy of the country could the foundations of true happiness and progress be laid, and added that the lessons in planned economy that have been learnt during the war could be put to good use for planning in peace. It is imperative, continued the Hon'ble Member, that every possible attempt should be made to increase the country's production of goods and services and to take steps to ensure that the increased production is so distributed that no one in the country gets less than a minimum of goods and services. The Hon'ble Member referred to the creditable efforts of the *National Planning Committee*, and the interest created by the *Bombay Plan* and a number of other plans. He stated that the Government of India too had been considering the subject for the last two years, and two Reports had been issued by the *Reconstruction Committee* of the Executive Council. The Government was, in the first instance, trying to consider in detail, the extent to which it was possible to obtain an increasing output of goods and services under the various heads of production. On this foundation, it would be possible to put forward an overall target in terms of the country's income. Government is attempting to obtain from the Provinces and some of the major States an idea of their requirements and the means at their disposal. It has already framed, or is in the process of framing, plans for the central subjects.

Individual targets have already been laid down in a number of cases, e.g., agriculture, communications and education, and adequate machinery was being set up for the ordered and guided development of industries. When sufficient material is collected, it would be possible to build up an all-India plan. The Hon'ble Member finally dwelt on the importance of economic and statistical research and the value of trained analytical judgment of the professional economists. The Government have already set up a Consultative Committee of economists and proposed to have a small sub-committee of non-official economists. It was considering the question of closer association with the *Indian Statistical Institute* and was also thinking of founding a **National Institute of Economic Research.**

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,, ,, A.R.I.	28 8
,, Carbonate	5 12
,, ,, A.R.I.	8 8
,, Chloride	2 8
,, Chromate, I.	10 7
,, ,, A.R.I.	33 0
,, Sulphate, A.R.I.	6 4
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,, Nitrate	2 6
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,, Nitrate	3 2
,, Nitrite	4 10
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,, Phosphate	3 0
,, PotassiumTitrate,A.R.I.	23 0
,, Sulphate	1 6
,, ,, A.R.	7 8
,, Stannous Chloride	9 8
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,, Chloride	6 6
,, Granular	5 12
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Letters to The Editor

DISPERSION OF SOUND VELOCITY IN ORGANIC LIQUIDS BY A NEW TECHNIQUE

INVESTIGATIONS on absorption of sound by gases have shown that dispersion of sound velocity exists in those regions of frequency where absorption is also known to occur. This has been explained theoretically[1]. Investigations of Parthasarathy[2], Biquard[3], Bär[4], Bazulin[5], Sorensen[6], and others on absorption of sound in liquids by various methods have indicated that certain organic liquids exhibit absorption of 10 to 100 times the theoretical value, calculated from the equations of Stokes and Kirchhoff, which take into account the absorption due to friction and heat conduction. Whether such absorption is accompanied by sound dispersion has been the subject of investigation by Bär, Hiedemann* and Parthasarathy, among others. The results have not been concordant and, therefore, not conclusive.

In any experiment on dispersion, the following factors should be taken note of:—

(*a*) the difference in temperature of the liquid when the diffraction pictures are taken at two different frequencies should be nil, as even a small difference by as much as a fifth of a degree Centigrade will give a difference of one metre per second;

(*b*) the diffraction orders should be as sharp as possible; and

(*c*) the diffraction patterns for the two frequencies should be obtained on the same photographic plate, preferably super-posed, so as to enable one to make the measurements between the fringes under identical conditions.

Though the method adopted by one of us (S.P.[3]) in an earlier investigation satisfied all the above three conditions to a large measure, there is yet the possibility that due to the short interval, of the order of 10 to 20 seconds, between the times the diffraction pictures at the two frequencies were taken, a small rise in temperature might have occurred. Even this has been eliminated in our present investigation. This has been made possible by exciting the piezo-quartz at the two frequencies simultaneously, as shown first by Bergmann and recently by Pande, Parthasarathy and Pancholy[7].

Using this method to excite the quartz crystal simultaneously at two frequencies, and in most cases at three frequencies, we obtained diffraction patterns due to each frequency as shown in Fig. 1. The slit was made as sharp as possible to give fine lines. These diffraction pictures for any one liquid were photographed on the same plate with the patterns superposed. Having obtained the diffracted orders on the same plate, the distances between several orders for the two frequencies separately were measured by a microscope, without disturbing the arrangement at all. All the sources of error were thus removed except that due to accuracy of measurement. The accuracy of measurement was determined separately. The following table gives the results of test measurements in five liquids:—

Liquids	Temp. °C.	Freq. Mc./Sec.	Velocity in Metres/ Sec.	Difference between velocities at two frequencies
1. Xylene ..	26.5	6.38	1325.5	+0.2
		15.85	1325.7	−0.7
		19.35	1326.4	
2. Carbon Tetrachloride.	24.0	4.04	931.3	−0.6
		13.36	930.7	
3. Toluene ..	24.5	5.19	1316.1	−0.2
		15.85	1315.9	+0.7
		19.35	1316.6	
4. Chloroform.	24.0	5.14	1003.1	−0.3
		15.84	1002.8	−0.2
		18.05	1002.6	
5. Aniline ..	24.5	6.51	1685.9	−0.7
		15.88	1685.2	+0.3
		18.03	1685.5	

As our measurements themselves are accurate only within one metre in a thousand, and as the differences in the last column are well

*Hiedemann (*Die Naturwiss.* 1936, **43**, 681) claimed to have obtained evidence for dispersion in *m*-xylene. Work carried out independently by S. Parthasarathy gave no dispersion at all. It was ascertained by correspondence that the dispersion reported by Hiedemann was due to some experimental error and that his results were in general agreement with those of Parthasarathy.

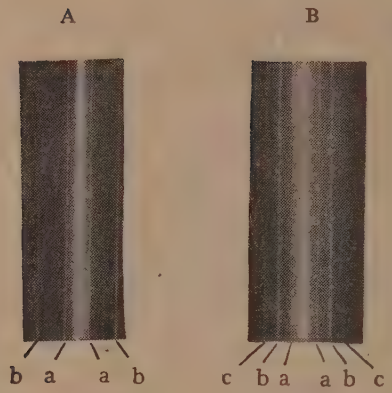

Fig. 1.—Diffraction patterns in (A) Carbon tetrachloride and (B) Xylene.

within 1 metre, it is claimed that, if any dispersion exists in the above liquids, it is not, at any rate, above one metre, and in all probability, in the range of frequencies investigated, there is no dispersion at all.

Further work is in progress.

S. PARTHASARATHY.
A. PANDE.
M. PANCHOLY.

Council of Scientific and Industrial Research, Delhi.
December 1, 1944.

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APPLICATION OF CHROMATOGRAPHY TO EXPLOSIVES

THE literature appears to show that little attempt has been made so far to apply chromatography to the analysis of explosives. The chief published data on these lines are the resolution of isomeric nitrophenols[1] and of nitroanilines[2]. The three isomeric nitroanilines are reported to resolve themselves into the following chromatogram by adsorption of a petroleum ether solution of the mixture on a column of lime:

p-nitroaniline	bright yellow
m-nitroaniline	yellow
o-nitroaniline	dark yellow to brown.

Isomeric nitrophenols adsorbed on columns of alumina or calcium carbonate also give bands in the above order. It has been suggested that the degree of adsorbability of these isomers is proportional to their dipole moments, the isomer with the maximum dipole moment forming the uppermost band[3].

Other workers[4] contend that it is least possible among organic compounds to resolve chromatographically mixtures of polynitrobodies, such as picric acid and trinitrobenzene. "These give on aluminium oxide and on most basic adsorbents deeply coloured complexes which are not broken down except by drastic chemical treatment."

Nitrotoluenes and naphthalene substitution products have been separated chromatographically, using activated alumina as the adsorbent and benzene as solvent[5]. Chromatographic method has been employed for the separation of dinitro- and trinitrotoluenes[6].

Our own interest in this field arose while engaged on the purification of styphnic acid. Preliminary observations are reported here.

Results

I—Styphnic acid (impure).

Solvent ..	Benzene.
Adsorbent ..	Talc or kaolin.
Pattern ..	Impurities on top (red). Styphnic acid at the bottom (yellow).

Talc or kaolin was pre-digested with dilute acid to remove traces of carbonates and finally washed with water and dried before use. This procedure was necessary to avoid formation of styphnates.

On developing the chromatogram with pure solvent, there was a clear separation of the red (impurities) and the yellow (styphnic acid) layers. The chromatogram was loosened, the two layers mechanically separated and the adsorbate recovered in each case by extraction with acetone.

II—Impure T.N.T. (from pre-sulphitation stage, a reddish-brown substance)

Solvent ..	Toluene.
Adsorbent ..	Talc.
Chromatogram.	Reddish brown adsorbate (*a*); Yellow filtrate (*b*).

On washing with toluene, adsorbate (*a*) remains firm while, on washing with petroleum ether, it is further resolved into cerise and brown layers.

Filtrate (*b*): On evaporating the solvent, the residue is a yellow solid m.p. 78° C. (mostly T.N.T. admixed with its isomerides).

Adsorbate (*d*): on extraction with acetone; a red oily residue is recovered (probably D.N.T. with isomerides of T.N.T.)

III—M.N.T. (*Red liquid*).

Solvent	..	Toluene.
Adsorbent	..	Sodium carbonate (anhydrous).
Pattern	.. Red	.. Top
	Yellow	.. Middle
	Violet	.. Bottom

Filtrate pale yellow (probably a mixture of isomerides of M.N.T.)

The chromatogram pattern represents impurities (not identified), the presence of which could not have been ordinarily suspected.

IV—Tetryl exposed to sunlight.

In contradistinction to the photo-decomposition products of T.N.T., which are insoluble in benzene and could thereby be separated from T.N.T., the tetryl decomposition products have been found to be, in general, similar to tetryl with regard to solubility, so that a separation of the decomposition products from tetryl is not ordinarily possible. Chromatography has been particularly useful in this case. Tetryl exposed to sunlight is resolvable into the components, namely, tetryl and the decomposition products, by passing a benzene solution of the irradiated material through a talc column. Tetryl passes into the filtrate, while the decomposition products are held on the top of the adsorbent.

The authors' thanks are due to Dr. H. R. Ambler, Ph.D., F.R.I.C., Chief Inspector of Military Explosives, for his kind interest in the work and to the Director of Armaments in India for permission to publish the results.

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CHROMATOGRAPHIC ADSORPTION OF SHARK LIVER OIL ON ACTIVATED FULLER'S EARTH

THE preparation of vitamins A and D concentrates from fish liver oils has assumed considerable importance during the last few years. Methods employed for securing such concentrates fall into four broad groups:

(1) Vacuum short path distillation.

(2) Adsorption on activated material followed by elution of the adsorbate.

(3) Extraction with a selective solvent which exerts a relatively greater solvent action on the unsaponifiable matter than oil itself. Glacial acetic acid has been employed as the solvent by some workers.

(4) Partial or total saponification of the oil and the solvent extraction of unsaponifiable matter.

By subjecting the liver oils to molecular distillation, it has been possible to remove much of their odour and to isolate a fraction rich in vitamin A, in the natural unsaponified condition; the isolates possess potencies upto 500,000 I.U./gm. Baxter and Robeson[1] record that from 50-70 per cent. of the initial vitamin A is obtained by using a cyclic molecular still similar to that described by Hickman. Whereas this method gives a good yield of vitamin A concentrates of high potency the equipment is very expensive.

In the fourth method, vitamin A gets concentrated in the unsaponifiable fraction but during the process of saponification the glycerides are destroyed and the vitamin A is subjected to the risk of oxidation.

The present paper deals with the preparation of vitamin concentrates from Indian shark liver oil by the method of chromatographic adsorption on activated Fullér's earth.

The oil was extracted from the livers of shark obtained from Bombay coastal waters by cooking the thoroughly washed and minced livers on a water-bath at a temperature of 70° C. The oil was then dehydrated with sodium sulphate.

Fuller's earth was activated by the method described by Burghardt[2]. A weighed quantity of Fuller's earth was treated with 5N. H_2SO_4 under reflux at 105° C. for six hours, washed with distilled water till free from acid, and the residue dried at 110° C.

Vitamin A assays were carried out colorimetrically by the antimony trichloride method

of Rosenhein and Drummond[3] as modified by Carr and Price[4] and further standardized by Coward, *et al.*[5] The photoelectric colorimeter was used as suggested by French[6]. Various fractions of the oil were weighed and made upto 25 ml. volume with dry chloroform. 0.5 ml. of this solution was pipetted into the colorimeter cell, 5 ml. of $SbCl_3$ reagent was then added. The photoelectric colorimeter readings were recorded, after 30 seconds. The rate of fading of the blue colour depends upon the concentration of vitamin A, the colour disappearing from the more dilute sample by the end of 10 seconds. The concentration of vitamin A was therefore adjusted within such a range that the blue colour value was constant for 30 to 40 seconds. This range was previously determined by using a standard vitamin A concentrate. The values of vitamin A were then calculated from a standard graph showing the relation between concentration of vitamin A in I.U./100 ml. of $CHCl_3$ solution and the deflection readings. *Cenco No.* 4 filter was used with the instrument.

Experimental

A glass tube, 1.2 cm. dia. x length 50 cm. was packed with 27 gms. of activated Fuller's earth under mild suction. 20 gms. of shark liver oil dissolved in 20 c.c. of benzene was passed slowly through the column, under gentle suction.

The following bands were distinguishable:

(1) A top band of 4.5 cm. which slowly deepened into olive green colour,

(2) Grass green band of 10.5 cm., and

(3) Bluish brown band of 8 cm.

The elution was carried out with 1 : 5 benzene: methyl alcohol mixture and the following fractions were obtained:—

Fraction	Zone from which it is eluted	Colour
Filtrate	....	Pale yellow
Eluate 1 ..	Lower half of 3rd zone ..	Yellow
„ 2 ..	Upper half of 3rd zone ..	Yellow
„ 3 ..	2nd zone	Orange
„ 4 ..	Lower half of 1st zone ..	Red
„ 5 ..	Upper half of 1st zone ..	Deep red

The solvents in each case were distilled off under vacuum and the residue taken up with chloroform and the vitamin estimated. The results are given in Table I.

It will be seen from the table, that the procedure has resulted in a sharp partitioning of two fractions; the first comprising the filtrate and eluates 1, 2 and 3 which constitute 19.25 per cent., of the original oil. The second fraction consists of the last two eluates accounting for the small portion of the remaining oil. The first fraction retains about 62 per cent. of the total vitamin activity with an average value of 6,660 I.U./gm. of oil. The second fraction has about 36 per cent. of the total activity concentrated in about 0.5 gm. of the eluate. The activity of this fraction is about 140,000 I.U./gm.

TABLE I

Fraction	Colour	Weight in gms.	Total vitamin A in I.U.	Vitamin A activity in I.U./gm.	% recovery of activity	% of increase of purity
Original Oil	Brown ..	20.0	211,400	10,570		100.0
Filtrate	Pale yellow ..	10.0	55,600	5,560	26.3	52.6
Eluate 1	Yellow ..	7.5	62,090	8,170	29 4	77.3
„ 2	Yellow ..	1.5	9,820	6,550	4 6	61.95
„ 3	Orange ..	0.249	1,400	5,620	0 6	53 2
„ 4	Red ..	0.273	21,000	77,200	12 5	730.3
„ 5	Deep red ..	0.237	50,000	211.000	23 7	1,995 0

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SHARKS
AND SHARK LIVER OIL INDUSTRY IN INDIA*

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Shark Fauna of Indian Waters

VERY little condentrated work has been done on the systematics of Indian Elasmobranchs since Dr. Day's time (1889) and complete records of their life history hardly exist. Indian waters contain representatives of various families such as *Orectolobidæ* (Cat sharks, Zebra sharks, Nurse sharks and Whale sharks), *Odontaspidæ* (Sand sharks), *Carcharhinidæ* (Blue sharks), *Sphyrnidæ* (Hammerhead sharks), *Rhinobatidæ* (Shovelnose and guitar rays), *Pristidæ* (Saw fishes), *Trygonidæ* (Butterfly rays, Whip rays, Sting rays), *Myliobatidæ* (Bat fishes and Eagle rays), *Mobulidæ* (Devil rays) and *Torpedinidæ* (Electric rays). The statement below gives a classificatory record of 41 species of sharks and rays found in Bombay waters. From this group, three species, viz., *Scoliodon ceylonensis*, *Carcharinus watu* and *Hemipristis pingali* are new, having been unrecorded elsewhere before.

Family—*Orectolobidæ*; Genus—*Chiloscyllium*, *C. griseum* (Muller and Henle); *Ginglymostoma*, *G. ferrugineum* (Lesson); *Stegostoma*, *S. tigrinum* (Forster); *Rhineodon*, *R. Typus* Smith.

Family—*Odontaspidæ*; Genus—*Odontaspis*, *O. tricuspidatus* (Day).

Family—*Carcharhinidæ*; Genus—*Scoliodon*, *S. sorrakowah* (Cuvier); *S. pallasorrah* (Cuvier); *S. walbeehmi* Bleeker; *S. ceylonensis Sp. Nov.*; *Hypoprion-H. macloti* (Muller and Henle); *C. limbatus* (Muller and Henle); *C. melanopterus* (Quoy and Gaimard); *C. bleekeri* (Duméril); *C. watu Sp. Nov.*; *C. menisorrah* (Muller and Henle); *C. species?*; *Galeocerdo*, *G. tigrinus* Muller and Henle; *Hemigaleus*, *H. balfouri* Day; *Hemipristis*, *H. pingali Sp. Nov.*; *Galeorhinus*, *G. musteleus* (Linné).

Family—*Sphyrnidæ*; Genus—*Sphyrna*—*S. blochii* (Cuvier); *S. zygæna* (Linné).

Family—*Rhinobatidæ*; Genus—*Rhynchobatus*, *R. djiddensis* (Forskal); *R. ancylostomus* (Bloch and Schneider).

Family—*Pristidæ*; Genus—*Pristis*, *P. cuspidatus* Latham; *P. perrotteti* Muller and Henle.

Family—*Trygonidæ*; Genus—*Trygon*, *T. uarnak* (Forskal); *T. uarnak var. variegatus* Annandale; *T. alcockii* Annandale; *T. gerradii* Gray; *T. bleekeri* Blyth; *T. walga* Muller and Henle; *T. sephen* (Forskal); *T. zugei* Muller and Henle; *Pteroplatea*, *P. pæcilura* (Shaw).

Family—*Myliobatidæ*; Genus—*Aetomylæus*, *A. maculatus* (Gray and Hardwicke); *Aetobatus*, *A. flagellum* (Schneider); *Rhinoptera*, *R. javanica* Muller and Henle.

* Contribution to the *Dictionary of Economic Products and Industrial Resources of India*. Suggestions are invited by the Chief Editor, 20, Pusa Road, New Delhi.

Family—*Mobulidæ*; Genus—*Mobula, M. eregoodoo-tenkee* (Cuvier); *M. mobular* (Bonnaterre).

Family—*Torpedinidæ;* Genus—*Torpedo; T. zugmayeri* Engelhart; *Narcine, N. timlei* Bloch and Schneider.

Sharks and rays attain a considerable size, the largest of the Indian species being the Whale shark, *Rhineodon typus* Smith. In Indian waters, it has been observed to grow to a length of 29′. Among some of the other large and common varieties may be mentioned the Gangetic shark—*Carcharinus gangeticus, Carcharinus melanopterus*, the Tiger shark—*Galeocerdo tigrinus*, the Hammerhead shark—*Sphyrna zygæna*, the Saw fish—*Pristis perrotteti* and the Shovelnose ray—*Rhynchobatus djiddensis*. Among these, the Tiger shark, the Gangetic shark and the Saw fish are very fierce and are known to attack man. The Gangetic shark is very common in the river Hooghly, where it is greatly dreaded.

Sharks and their allied kind—the skates and rays—are of considerable economic importance. Some of the smaller varieties, especially those with black-tipped fins—*Carcharinus limbatus, Carcharinus bleekeri*, small-sized *Carcharinus melanopterus* and *Sphyrna zygæna* and *C. menisorrah*—are consumed fresh and are generally administered to women after child-birth. A chemical analysis of the flesh of sharks and rays reveals that it is rich in protein content, it being about 20—25 per cent. of the entire muscle. The flesh of larger sharks, too, is important as food. It is filleted and salted in the fish curing yards all along the coast and disposed of in the interior, where it is in great demand. Recently, smoking of shark fillets has been undertaken both along the Bombay and Madras coasts and the resulting product is most satisfactory. Such portions of the fish as are unconsumed are converted into manure. Even fins of the larger varieties of sharks and rays are also edible as they are used to make soup. Large quantities of such fins were exported annually to China, England and Germany before the war. Sharkskin is excellent as leather, but so far there are no sharkskin factories anywhere in India. In recent years these fishes have acquired a growing importance for the valuable medicinal oil yielded by their livers.

Graded Value of Sharks

Unlike Cod liver oil, oils obtained from various sharks and rays show wide specific variations in their vitamin values thus permitting of a tentative gradation of the fishes in order of the vitamin-bearing qualities of their liver oils. This factor, combined with the relative abundance of different species in different regions and depending, in its turn, upon the regional richness or otherwise of certain kind of fish food, determines the relative importance of the different species to the shark liver oil industry of a particular region. Two species of tiger shark, viz., *Galeocerdo tigrinus* and *G. rayneri* are most common in Indian waters and principally support the liver oil industry, though, of course, the oil is not comparatively quite so rich in vitamin content. Another species, viz., *Odontaspis tricuspidatus* occurring along the Bombay coast yields oil the vitamin value of which is practically nil. This shark is not quite common in the Bombay waters. The sharks described below are listed in order of their relative importance to the industry so far as it concerns the Bombay province and it is quite likely that there may be a difference gradation along the Sind and Madras coasts.

Khada mushi (*Carcharinus melanopterus*) is exceedingly rich in vitamin A. The fish grows to a good size, attaining a length of about 10′ and weighing as much as 1,500 lbs. The maximum recorded weight of the liver of an individual of this variety was 106 lbs. Such large livers generally yield from 50 to 70 per cent. of oil. The shark is fairly abundant along the coast and the extraction of oil from its liver on a commercial basis would be very profitable. The exceptional richness of oil from the liver of this fish in respect of vitamin A may be gauged from the fact that one sample gave a Blue value of 91,108 and another 45,450 per gm. Such oils can be regarded as concentrates of vitamin A. Normal oil from this shark is lemon yellow in colour, whereas exceptionally rich oil is high-coloured, being almost brown.

Oil from the hammerhead shark—*Sphyrna zygæna*, locally known as *boot*, is also very rich in vitamin A content. It, too, grows to a fairly large size, but it does not appear to be so common along our coast as *khada mushi*. Every effort to capture full-grown individuals of these two varieties

of sharks on a large scale is, indeed, worthwhile, in as much as they yield large quantities of oil, which is nothing less than a concentrate of vitamin A.

Larger livers, too, are obtained from the shark locally known as *waghbeer* or *waghsheer* (*Galeocerdo tigrinus*). This shark grows to a length of about 13′ and weighs about a ton. The largest liver obtained from this variety weighed 150 lbs. Livers of this shark yield about 60 to 70 per cent. of oil. The vitamin A content of the oil is on an average about 1,000 Blue units per gramme, which cannot be considered high and may be rated fair. The largest tiger shark recorded in Madras has been found to measure 30′ in length, with a liver weighing 260 lbs.

The saw fish *nali*, *win*, *sondel* or *khandere* (*Pristis perrotteti*) is also known for the copious yield of oil from its livers. The liver weighs as much as 100 to 120 lbs., and the oil is fairly rich in vitamin A content. These fish, too, attain a considerable length, and specimens as long as 21′ have been landed.

Livers from the ray *Rhynchobatus djiddensis*, locally known as *ranja* or *pok*, which is recorded as growing to 9′ in length, are too small to be of much value from a commercial point of view. The same may be said of the sharks *pisori* (*Carcharinus limbatus*), *kirwa* (*Carcharinus sp.*) and *kanar* (*Sphyrna blochii*). Small livers from these varieties yield about 25 to 30 per cent. of oil, and large quantities of livers would be needed for the extraction of oil. Oils from the livers of *pakat* (*Trygon spps.*) and *wagli* (*Ætobatus sp.*, *Ætomylæus sp.*, *Rhinoptera sp.* and *Mobula sp.*) do not possess a high vitamin A content and cannot, therefore, be regarded as of much value medicinally.

Observations have shown that dark, mottled livers yield oil of a higher potency than plain livers. Adult males generally yield oil richer in vitamin A content than non-gravid females of a corresponding size. Further, gravid females carrying young ones, have shrunken livers owing to the space in the abdomen being occupied by embryos, but the oil from such livers is richer in vitamin A potency than that of livers of non-gravid females. The area in which fish are caught and the variety and abundance of food available in different localities also exercise a marked effect on the vitamin A content of shark liver oils. Oils from sharks caught in the Karachi area are usually high in vitamin A content, whereas oils from sharks of the Konkan coast are not so rich. The superabundance in the Karachi area of prawns and shrimps, which are full of carotenoid pigments, and the comparative dearth of this important fish food in the Konkan may possibly account for the difference in the vitamin A potency.

Intensive Shark Fishing

The foregoing facts show that the shark oil industry possesses great potentialities, but there is no organized shark fishing. Such sharks as are landed are invariably caught by their being entangled in the nets used to catch fish for the local markets. An essential basis for the progress of the oil industry is that sharks should be more intensely fished for. Elsewhere in the world, the manufacture of shark liver oil is being intensified to supplement the deficiency caused by the comparative unavailability of cod liver oil. Big companies and syndicates have been formed for the capture of sharks, skates and rays that formerly were thrown back into the sea. Boat-loads of livers are now landed, and the value of their sales exceeds all former records. This would not have been possible but for the systematic and well organized hunts for sharks.

No elaborate tackle is needed for the capture of sharks, and there is no reason why our fishermen cannot make an effort corresponding to that of their fellow-fishermen in other parts of the world. Our fishermen have, through trial and error, developed in their own way tackle for the capture of sharks. This consists of long lines which, as the name implies, is a lengthy line of hemp or cotton, to which are attached, at regular intervals, short lines with hooks. The hook carries the bait. A long line when set runs to several hundred feet and is furnished with hundreds of baited hooks. What our fishermen need only do is to concentrate on shark hunts, to use longer lines, larger and greater numbers of powerful hooks and to go further out to sea. An encouraging sign of late has been the increasing number of fishermen who, with Government's assistance are now taking to fishing for sharks with hooks and lines.

Experiments in this direction have already borne fruit in Bombay. Fishermen of Karanja, an island barely seven miles south-east of the city, have made trips exclusively in search of sharks. Two boats between them captured thirteen *waghbeer* (*Galeocerdo tigrinus*) of a total weight of 13,000 lbs. Their oil was disposed of for Rs. 2,500. The sharks were caught by ordinary fishing boats, whose only tackle consisted of twine and hooks. One departure was made, however, on this department's recommendation, namely, that the hooks were fastened to the main line by means of dog's chains, instead of twine which usually breaks when the sharks struggle for liberty.

The occurrence of sharks in fairly abundant quantities and not far off from the fishing villages along the whole of the western coast of India thus encourages the view that the extraction of oil from shark livers would furnish the basis of a flourishing industry. The return in store for whatever efforts our fishermen make is great and there is no doubt that the industry will have its own assured position even after the war.

Shark Liver Oil Industry in India

The question of the production and supply of a suitable indigenous cod liver oil substitute assumed considerable importance in this country about 1940, when, on account of the war, cod liver oil which had, hitherto, been used generally for the treatment of vitamin A deficiency, became virtually unprocurable. Preliminary research in this direction undertaken by the *Madras Fisheries Department*; in collaboration with the *Nutrition Research Laboratories, Coonoor*, revealed that shark liver oil would provide a good substitute, as it was found to be a rich source of vitamin A in semi-concentrated form. Even long before the outbreak of the war, the question of the extraction of shark liver oil had engaged the attention of Dr. B. Sundara Raj, late Director of Fisheries, Madras. The data yielded by his investigations furnished the foundation on which Fishery Departments in other Provinces have since organized the shark oil industry. The belief in the possibility of the extraction of oil from the livers of sharks, skates and rays and the establishment of a flourishing medicinal oil industry on a sound basis was strengthened by the occurrence, in abundance, of this important group of fishes along the whole of the western and eastern coasts of India.

A meeting of the Fisheries Committee of the *Imperial Council of Agricultural Research* was held in 1940 when the attention of various Provincial Fisheries Officers was drawn to the serious dearth of cod liver oil supplies in India since the start of the war, and the need was emphasized of the various Provincial Fisheries Departments interesting themselves in the establishment of this new industry in their respective provinces.

Accordingly, the Madras Fisheries Department started work on the commercial manufacture of shark liver oil in August, 1940, and Bombay did likewise in the following month. Maritime States like Baroda and Travancore as well as Karachi, also entered the field, with the result that the industry now appears to be more or less firmly established in this country with bright prospects for its expansion in the future.

Madras tops all other maritime areas in the matter of its output of shark liver oil. Next in order come Bombay, Karachi, Travancore and Baroda. The Madras Government, in keeping with its pioneer enterprise, has also been the first to set up at Calicut a factory for the manufacture of *Oleo-vitaminatum*. No actual statistics are available of the total quantity of oil produced in Madras, Bombay, Baroda, Travancore and Karachi during the past four years but an output of about 1,500,000 lbs. of oil of cod liver oil standard would not be an extravagant claim. A great part of the output has been absorbed by the Indian Stores Department, the balance being taken by various public and private hospitals and medical institutions throughout India.

The therapeutic value of shark liver oil has been firmly established and its suitability as a substitute for cod liver oil is unquestioned. Medical practitioners and the general public alike testify unanimously to its beneficial effects on the human system. The scope of its use for nutritive purposes is much wider than would be generally supposed, so that its manufacture on a commercial scale is rapidly extending throughout the country and so vital has this need become that our commercial fisheries are faced with a great opportunity to develop a new source of income by organizing a new

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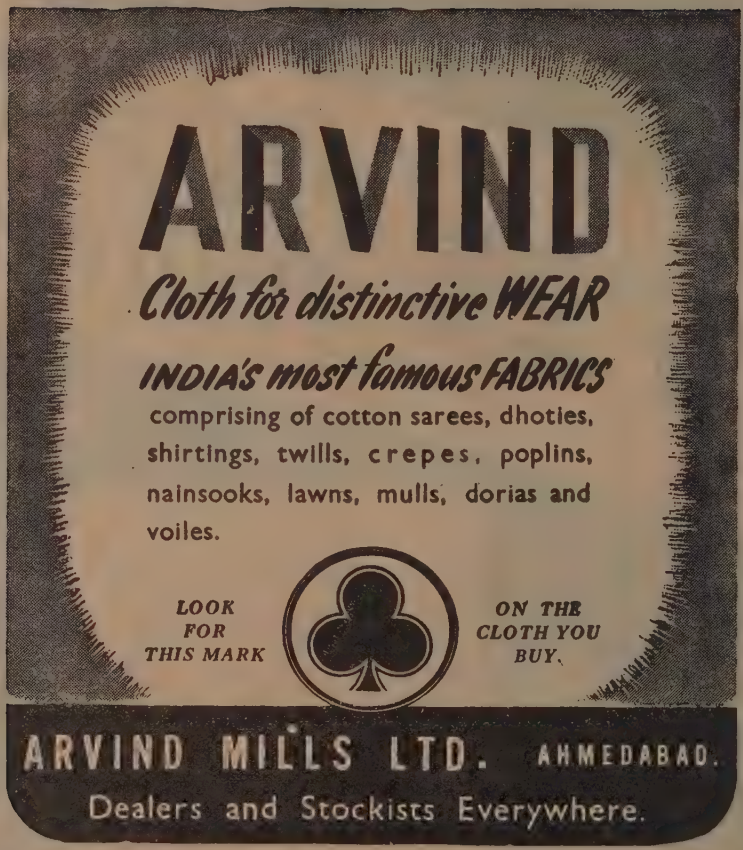
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Index to Advertisers

	Page
Addison & Co., Ltd., Madras and Bangalore	xvi
Alembic Chemical Works Co., Ltd., Baroda	xxi
The Andhra Scientific Co., Ltd., Masulipatam	xiii
Arvind Mill, Ltd., Ahmedabad	xii
Bengal Chemical and Pharmaceutical Works, Ltd., Calcutta and Bombay	xviii
Chimanlal Bhogilal, Bombay	xxii
Hargolal and Sons, Ambala Cantt.	xvii
Hindustan Aromatics Co., Naini, Allahabad	viii
Industrial Chemical Works, Kirloskarvadi	xx
J. K. Industries, Cawnpore.	v
Kerala Soap Institute, Calicut	xviii
Modi Industries, Modinagar	iii, xvi
Mining and Chemical Industries Ltd., Agra	iv
Oriental Science Apparatus Workshop, Ambala Cantt.	xv
S. C. Sheth & Co., Ltd., Bombay	xxii
Scientific and Industrial Equipment Co., Ltd., Bangalore	xx
The Scientific Apparatus and Chemical Works, Ltd., Agra	xxiii
Scientific Instrument Co., Ltd., Allahabad, Bombay, Calcutta and Madras	vi
Sepulchre Brothers (India), Ltd., Bombay	iv
B. Shivchand Amritlal & Co., Bombay	xi
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Zill & Co., Bombay	ix, x

and prosperous fishery. A good deal of research has recently been carried out in different parts of India on vitamin A values of oils extracted from various fishes, particularly sharks and rays. These investigations have prominently indicated the relative importance of various sharks in regard to the yield of oil from their livers and their respective vitamin A potencies.

Great Possibilities

The increasing tendency to fortify articles of food deficient in dietetic value has opened up a fresh field for the use of shark liver oil. Thus, oil rich in vitamin A and D content is employed to fortify not only human food but also the feed of poultry and quadrupeds that figure in man's diet. The value of food thus fortified has been recognised by the U. S. Government, in whose programme for the improvement of the nutrition of the American people this factor occupies an important place.

Similar recognition of this factor in our country would provide a ready outlet for the more extensive use of fish livers. One or two isolated instances of the use of fish liver oils will suffice to prove the importance of this new departure in the sphere of dietetic research. The food authorities in the U.S.A. are widely using shark liver oil to fortify oleomargarine. Perhaps, similar scope for the use of shark liver oil might be found in India to fortify animal and vegetable products used as cooking media. Products thus fortified may be brought on an equal nutritive standard with ghee or butter and will eventually prove, from the mere dietetic point of view, a boon to countless people who, owing to the lack of sufficient means, are unable to afford ghee and butter.

A lead in this direction has already been taken in the Province of Madras, where shark liver oil is being used to fortify malt at Government Malt Factory, Coimbatore.

Experiments are also in progress at the Haffkine Institute, Bombay, to prepare concentrates from neat oil with a view to their use to fortify food for areas suffering from the effects of malnutrition. The Nutrition Research Laboratory at Coonoor and the Institute of Science at Bangalore are also conducting useful research to discover a more extended use of shark liver oil.

An idea of the far-reaching effects of food fortified with this oil is furnished by results obtained in the U.S.A., where it has been conclusively established that fortified poultry feed has exerted a beneficial influence in such diverse directions as production of eggs, hatchability and growth of the birds. Increased production of both poultry and eggs is to-day of paramount importance in India, where the growing needs of the expanded military forces make it imperative that as plentiful a supply of nutritive food should be readily available. Equally profitable results have been obtained by the administration of fortified food to four-footed farm animals such as hogs. India is an agricultural country and there seem to be reasonable grounds in support of the view that the consumption of fortified food by our bovine species may be accompanied by richer and more abundant yield of milk as well as an improvement in the quality of their flesh, with incalculable benefit to our agricultural economy.

Process of Manufacture

The method employed in the extraction of oil is simple and inexpensive. No elaborate apparatus is needed, so that even the poorest fisherman can be a producer. As a matter of fact, long before the outbreak of war, oil from shark livers was already being extracted along the coast, but by extremely crude methods. The oil was not meant for therapeutic administration, but was used as a protective agent to coat the sides of fishing boats. It was also used as a lubricant and for painting.

The production of oil in Madras, Travancore and Baroda is centralized, the livers being bought by their respective Fisheries Departments, which then extract the oil. In Bombay, on the other hand, the industry is diffused. A simple apparatus has been devised and made available to fishermen along the coast, who extract the oil under the supervision of the staff of the Fisheries Section. The oil is despatched to the Fisheries Office in Bombay, where, after testing, it is stored for sale.

The underlying principle in the extraction of the oil is almost identical everywhere, being the application of heat to the liver mass, so that liver cells are disintegrated and the oil contents liberated. The oil floats to

the top and is ladled off. The oil is then carefully filtered free from any liver tissue and dehydrated with a sufficient quantity of anhydrous sodium sulphate.

Utmost care has to be taken to avoid exposure to light and minimize contact with air both during extraction and storage as both these physical factors have appreciable deteriorative tendencies on the vitamin content of the oils. Wholesome oils, hygienically extracted from fresh, clean livers will be of clear yellow, orange or brown colour, with a mild fishy odour and low acidity. The various physical and chemical properties and vitamin A values of oils from a number of commercially important varieties of sharks and rays of the Bombay waters are indicated in the table.

A glance at the table will show that oils obtained from the different varieties, despite an apparent similarity in respect of physical and chemical properties, vary widely in respect of their vitamin A value. The wide disparity emphasizes the need to standardize oil from various sharks in respect of their vitamin A and D contents—the most important aspect from a medicinal point of view—before it is placed on the market.

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TABLE

S. No.	Scientific name	Colour	Sp. gr. at 25° C.	Ref. index at 25° C.	Iodine value (Wij's)	Acid value	Sapon. value	Acetyl value	Unsap. matter %	Vitamin A content: Blue units per gr.
1	*Carcharinus melanopterus* .. .	Reddish brown	0.9210	1.4752	127	0.627	171	28.32	9.23	91,108
2	*Sphyrna zygæna* ..	Do.	0.9195	1.4746	132	0.573	169	38.08	8.37	55,752
3	*Carcharinus melanopterus*	Do.	0.9230	1.4764	131	0.878	167	30.87	8.45	45,450
4	*Do. do.* ..	Do.	0.9190	1.4732	122	0.578	172	24.13	6.67	32,725
5	*Sphyrna zygæna* ..	Amber yellow	0.9180	1.4732	127	0.324	170	44.71	1.75	15,600
6	*Pristis perrotteti* ..	Orange	0.9150	1.4650	110	1.556	186	13.90	3.73	4 650
7	*Galeocerdo tigrinus* .	Lemon-yellow	0.9120	1.4640	111	0.457	180	52.02	2.53	3,700
8	*Sphyrna blochii* ..	Brown	0.9183	1.4700	154	0.865	181	78.61	1.80	2,750
9	*Carcharinus sp. ?* ..	Lemon-yellow	0.9100	1.4648	108	0.225	186	17.43	0.85	2,150
10	*Rhynchobatus djiddensis*	Pale yellow	0.9380	1.4704	114	0.963	170	27.21	1.33	1,475
11	*Carcharinus limbatus* .	Do.	0.9177	1.4710	146	0.326	177	39.20	1.03	675
12	*Trygon uarnak* ..	Do.	0.9150	1.4678	137	0.472	183	50.10	2.30	475
13	*Rhinoptera javanica* ..	Orange	0.9150	1.4652	116	0.693	186	25.57	2.34	375
14	*Ginglymostoma ferrugineum*	Pale brown	0.9168	1.4708	124	0.194	186	13.94	0.96	350
15	*Odontaspis tricuspidatus*	Almost colourless	0.9177	1.4720	143	0.463	156	60.08	2.38	0
16	*Hemipristis pingali sp. nov.*	Deep brown	..	..	..	..	..	..	..	18,723
17	*Rhynchobatus ancylostomus*	Orange	..	..	..	..	..	..	..	Traces

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ULTRASONICS

THEIR SCIENTIFIC AND INDUSTRIAL APPLICATIONS

By S. PARTHASARTHY and A. PANDE

(*Council of Scientific and Industrial Research, Delhi*)

THE study of "inaudible" sound, more usually called "ultrasonics" or "supersonics," has attracted considerable attention in recent years and has resulted in applications in as widely different fields as theoretical physics and agriculture. A brief survey of the technical applications of ultrasonics and of their vast potentialities for scientific and industrial research* is attempted in this article.

Generation of Ultrasonics

Various kinds of supersonic generators have been described, the more important among them being the Magnetostriction and Piezo-electric quartz oscillators. Both employ high frequency electrical oscillations which are produced by the use of valves and other radio components ; their circuits are given in standard books and journals The magnetostriction effect was discovered by Joule[1], who found that when ferro-magnetic or nickel tubes were placed in an alternating magnetic field parallel to their lengths, the latter expanded and contracted with double the frequency of the applied fields and generated sound waves due to their longitudinal expansions and contractions. This method of oscillation was employed by Pierce[2] for measuring the velocity of sound with the acoustic interferometer, and by Gaines and Chambers[3] in their spectacular experiments on the biological effects of supersonics. The chief merits of the magnetostriction generator lies in the simplicity of its construction and its cheapness, but its utility is restricted by the circumstance that it is not possible to generate stable frequencies exceeding 300,000 cycles per second on account of several uncontrollable factors in its working. Piezo-electric oscillators, on the other hand, are capable of producing powerful mechanical oscillations.

It was discovered by Curie[4] brothers that when a number of crystals such as tourmaline, quartz, Rochelle salt, etc., are subjected to mechanical pressure, electric charges are produced on their surfaces. Further, these crystals undergo alterations in their linear dimensions when placed in an alternating electric field. This effect had been predicted earlier by Lippmann[5] from purely thermodynamical considerations. Piezo electricity remained a laboratory curiosity until World War I; in 1917 Prof. Langevin[6,7] employed the piezo-electric property of crystals for the detection of submarines. Since then, the number of applications of supersonics has steadily increased. Stable frequencies of the order of 60 million cycles per second have been obtained by Bär[8] and others by the use of the piezo-electric oscillations. Powerful generators, using plates of quartz crystals as resonators have been constructed by Wood and Loomis[9] and also by Bhar[10] for the production of high acoustical energy.

A visual demonstration of the magnitude of the radiation pressure can be obtained

Fig. 1.—Fountain produced by Ultrasonics.

*Investigations are being carried out on this subject in the Laboratories of the *Council of Scientific and Industrial Research.*

by exciting a quartz plate immersed in an oil medium in which stationary waves are set up and a mound of oil is thrown up. When the frequency of the electrical oscillations is in resonance with the natural frequency of the crystal plate, the oil mound rises up to a height of 8 to 10 cms., its summit erupting oil drops like a miniature volcano. A photograph of such a fountain is reproduced in Fig. 1. For obtaining the maximum output of energy from such a generator, Gruetzmacher[11] employed a spherical quartz plate, and by concentrating the whole of the acoustical energy at the focal point, he was able to produce a fountain rising to a height of about 50 cms.

The physical and chemical effects produced by ultrasonics are mainly due to (1) the directional properties acquired by the waves on account of their small wave-length, and (2) the absorption of energy, mainly in the form of heat, by the medium and thus causing chemical changes. In addition, effects due to mechanical agitation transmitted to the molecules of the medium are also manifested.

Physical and Chemical Effects of Ultrasonics

A few important properties associated with the high frequency sound waves will be given here by way of introduction to their technical applications. Strictly speaking, ultrasonics have no properties of their own but only produce certain physical and chemical effects in the substances subjected to them. If a liquid lies in an ultrasonic field, a considerable rise of temperature is observed in the liquid due to the absorption of energy. Intense ultrasonic waves have the effect of emulsifying immiscible liquids such as water and benzene or water and mercury into stable emulsions. Similarly a number of metals, e.g., sodium, potassium, mercury, etc., can be dispersed in alcohol and oil through the agency of ultrasonic waves. This is due to the molecular agitation imparted to the liquids. Often degassing of liquids takes place.

When a beam of ultrasonics is passed through a liquid, condensations and rarefactions take place within the body of the liquid and consequently changes in the refractive index of the liquid column are produced resulting in a corrugated wave front. If a ray of monochromatic light is passed through such a liquid column, diffraction analogous to that shown by an optical ruled grating takes place. A comprehensive theoretical explanation of this phenomenon was furnished by Raman and Nath. A similar diffraction phenomenon is also observed in solids, which provides an elegant technique for the investigation of wave systems in solids as well and finds numerous applications in the scientific and technical fields. A few photographs of the diffraction patterns obtained in the Laboratories of the *Council of Scientific and Industrial Research* are shown in Fig. 2.

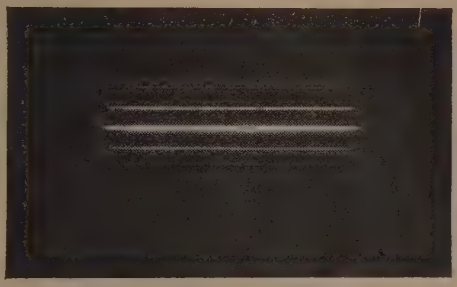

Fig. 2.—Diffraction spectrum of ultrasonic waves in carbon tetrachloride (Parthasarathy, Pande and Pancholy).

Optical Effects produced by Ultrasonics and their Applications.—It was discovered by Lucas and Biquard[12], and by Debye and Sears[13] almost simultaneously, that diffraction of light, for which a complete explanation was furnished by Raman and Nath, occurs in a liquid traversed by ultrasonic waves. According to Raman and Nath[14], the angle of diffraction of light is given by the equation :—

$$\text{Sin } \theta_n = \frac{n\lambda}{\lambda'} \quad (n=1, 2, 3, 4.....)$$

Where θ_n is the angle of diffraction of the nth order, λ is the wave length of light and λ' the wave length of sound. The diffraction method offers a spectroscopically accurate method of determining the velocity of ultrasonics in liquid, solid and gaseous media. Measurements of sound velocities in liquids render possible the determination of adiabatic compressibilities (β_{ad}) and Cp or specific heat at constant volume. The usual methods for the determination of these constants are beset with considerable experimental difficulties.

The diffraction technique can be utilized for the study of the modes of piezo-electric oscillations of quartz and other crystals and

for determining the exact frequency at which the crystals are vibrating. Parthasarathy, Pande and Pancholly[15] have shown by this method that a quartz crystal is capable of oscillating not only in the odd harmonics, as had been shown by earlier workers, but also in the even harmonics and half of odd harmonics. Similarly, by exciting the crystal by two oscillators, Bergmann[16] and Parthasarthy[17], independently, showed that a crystal is capable of oscillating simultaneously at both the frequencies giving a complex diffraction pattern. Also by measuring the intensities of diffraction lines produced by the crystal along its three axes, it is possible to measure the Possion's ratio for quartz accurately.

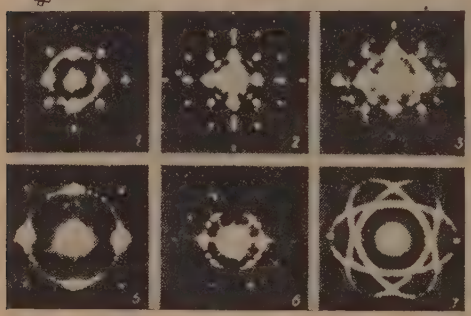

Fig. 3.—Diffractions Patterns obtained by the passage of ultrasonic waves through crystals (Schaefer and Bergmann).

Elastic and Elasto-optical Constants of Glass.—Schæfer and Bergmann[18] imitated the Laue X-ray diffraction pattern by passing a narrow beam of light through a transparent solid in which ultrasonic waves were propagated. Some of the photographs obtained by them are shown here in Fig. 3.

Using the diffraction technique, Schaefer, Bergmann and Goelich[19] determined the elastic constants of seventy varieties of Schott's optical glass. Hiedeman and Hans Muller[20] employed the same technique for the accurate determination of the elasto-optical constants of glass. More recently, Ludloff[21] determined the elastic constants of optical glasses at various temperatures.

Television

Jeffree[22,23] was the first to show that the Debye-Sears diffraction effect could be employed for the light control of negligible inertia and power consumption, and with reasonable light efficiency upto the highest picture definition. He pointed out that when light is modulated by stationary supersonic waves, the frequency of modulation is twice as much as that of the supersonic waves. This modulation effect finds a series of practical applications, the most important among which is the Socophony system of television (developed by Okolicsanyi[24], Robinson[25] and others). In this system a glass trough filled with a transparent liquid and traversed by high frequency sound waves acts as a light valve. The crystal is excited by high frequency electromagnetic waves of the order of 10 million cycles per second. The amplitude of the carrier wave is modulated by the videosignal received from the transmitter. The combination of the supersonic light control with cylindrical lenses (to focus the light rays) is the principal feature of the Socophony system that permits the production of large images. It furnishes a practical means of 'storing' picture signals at the receiving end, in the same manner as the iconoscope does at the transmitting side. The diagram of such a system is shown in Fig. 4.

The possible applications of the ultrasonic diffraction cell are many. Its simplicity and its characteristic constant time delay render

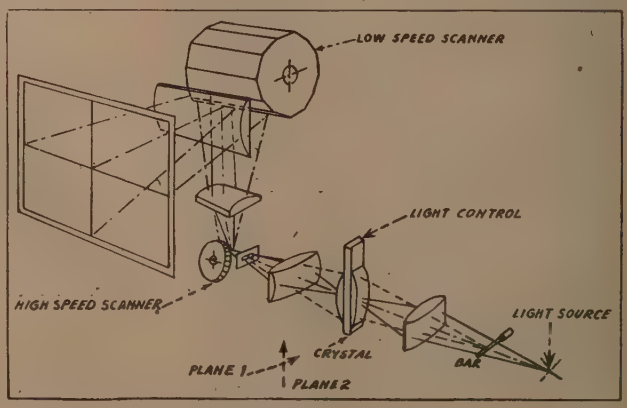

Fig. 4.—Optical Diagram of Socophony. Television Receiver.

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it a unique and invaluable instrument in the field of optical mechanical television. It has been recently employed for measuring very small intervals of time—of the order of 10^{-6} sec.—, in the study of the duration of the excited state of molecules. An exhaustive account of the Socophony system of television can be obtained elsewhere[26,27,28].

Submarine Detection and Echo Depth Sounding

The possibility of using an ultrasonic transmitter for detecting the presence of icebergs was first suggested by Richardson[29] at the time of the Titanic disaster. The advantages of using ultrasonics, in preference to the audible sound waves, are twofold. The intensity of the radiated beam can be greatly enhanced without, at the same time, increasing the amplitude of the source. Next, a directional effect is secured by the use of a beam of sound produced when the frequency reaches about 300 Kc./sec. Langevin used ultrasonics successfully for submarine detection. By using fairly high frequencies (38,000 cycles/sec.), Langevin made it possible to project a narrow beam of sound radiation, which when returned as an echo could be transformed back into high frequency electrical oscillations by the same crystal that emitted the short blast of supersonic radiation and these impulses could be made audible by the hetrodyne technique employed in radio communication. Submarine transmitters have three important applications. In the first place, they are used in "signalling" which may be done either by Morse or by telephony, the quartz vibrations being modulated by the speech frequencies. The second application is in the determination of the position of ships, submerged submarines, etc., by "echo sounding," the accuracy of the measurement of distance being about 1 per cent. The transmitters are also employed for measuring the depth of the ocean and for mapping the ocean bed. Echo-sounding equipments using piezo-electric quartz transmitters and receivers were being manufactured in Germany and France before this war. The echo-sounding principle has since been used in aircraft altimeters[30].

Supersonic Testing Methods

Three methods of utilizing supersonics for testing materials are recognized. They are :—

(*a*) Vibrations are set up in the article under test and the frequency of the emitted sound is checked against the tone of a standard specimen;

(*b*) the duration of sound given out by the test article when vibrating freely is measured ; and

(*c*) a beam of ultrasonic waves is passed through the sample to be tested and the resulting reflection or absorption of waves is measured.

Vibration Frequency.—The traditional method of testing coins is to ring them to ascertain their "genuineness." The authenticity of various metals can be judged by experienced people by a similar method. In the industrial field, files, grinding stones, castings, etc., are frequently tested in this manner. This method, however, is totally inapplicable when the frequency of the emitted tone exceeds the range of audibility, i.e., 20,000 cycles per second. In such cases the waves should be made audible. An instrument called "audio hetrodyne amplifier" consisting of an oscillator that beats with the incoming sound frequency and produces an audible tone, has been recently described by Andrews[31], which is analogous to the superhetrodyne receiver, employed in radio communication. A special crystal cell microphone for the detection of supersonic frequencies is attached to the amplifier.

Duration of Sound.—The second method of flaw detection involves the measurement of the duration of sound emitted by an article. The amplitude of the vibrations set up in an object decreases exponentially with time. A measure of the specific damping capacity is obtained by determining the logarithmic decrement of vibration. The object is first excited at its natural frequency and then at frequencies on either side of the peak frequency ; the amplitudes are then measured and analysed. The analysis is somewhat like the "Q" measurements taken on coils. The method can be used for testing glasses and goblets and also the bondage between two pieces of metals as in steel-backed bronze bearings. The apparatus required for the test includes an audio-oscillator, a vibrator, an oscilloscope and a vacuum tube voltmeter.

Reflection and Absorption of Supersonic Waves.—In this method supersonic waves are actually passed through the specimen to be tested and the resultant reflection or absorption measured. The method is more precise than the two previous ones, but the

equipment required is somewhat more complicated. The object to be tested is mounted on a suitable support ; the piezo-electric crystal generator is attached to one end of the specimen and a detector consisting of a Rochelle salt crystal is attached to the other end. The quartz crystal is connected to a high frequency electromagnetic oscillator modulated by an audio frequency (say, 50 cycles per second) pulse. The Rochelle salt crystal detector is connected to a cathode ray oscillograph (through an amplifier and a rectifier) for visual observations of the reflected waves travelling along the test specimen. The tests are first conducted on a number of standard specimens and the reflected waves visible on the oscillographic screen can be photographed. With a flawless pattern a series of reflected pulses occurring at regular intervals are observed, but if there is any flaw, extra pulses are observed as shown in the Fig. 5. The technique is similar to that employed in the field of ionospheric investigations using pulse signals from a local transmitter.

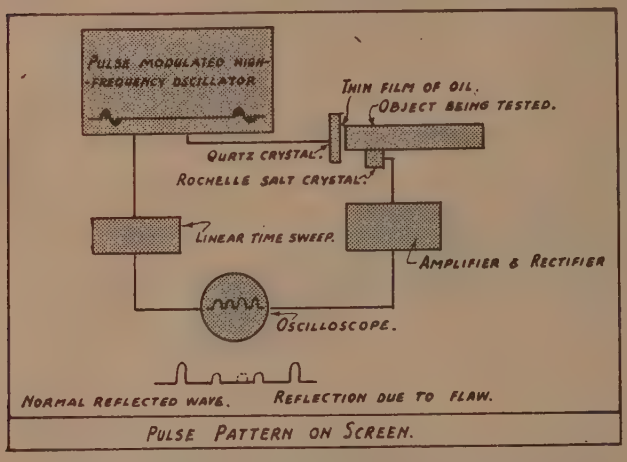
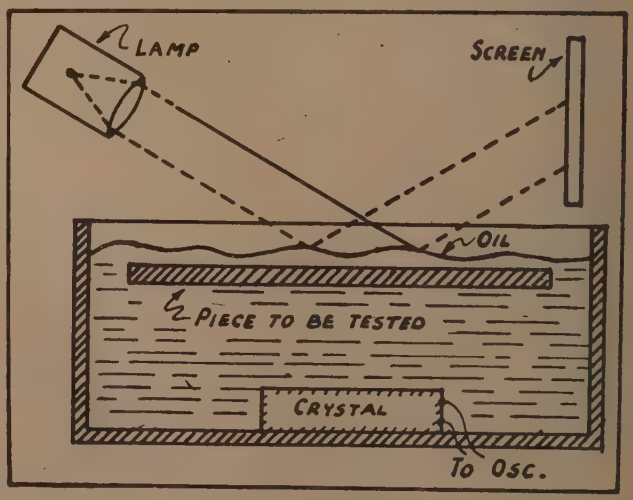


Fig. 5.—Flaw detection by observation of reflected supersonic waves.

The absorption of supersonic waves in metals is very small and, therefore, even weak ultrasonic waves can traverse considerable thicknesses of metals without serious loss of energy. But if a heterogeneity caused by a crack or a crevice or any other similar defect intersects the path of the beam the vibrations will not pass through. Based on this principle, Sokoloff[32] investigated the heterogeneities of various metals by transmitting the oscillations in various mutually perpendicular directions. The sketch of the apparatus used by him is shown in Fig. 6. It consists of a "compound crystal" made from a mosaic of quartz pieces sandwiched between two steel plates. A drop of mercury is employed as the coupling link between the oscillating quartz and the sample under test. The vessel containing the oscillator was so mounted that it could be moved both in the vertical and horizontal directions and at the same time, proper contact was secured with the sample to be tested at different places. A small basin containing benzol or other



SOKOLOFF'S APPARATUS

Fig. 6.—Flaw detection by immersing specimen in oil and sending a supersonic beam through it.

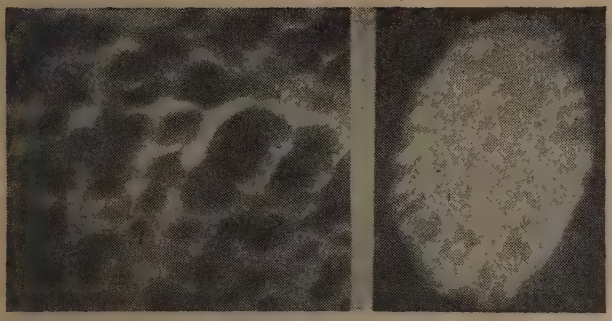


Fig. 7 (a).—Oil vibrations (Sokoloff).

transparent liquid was placed on the surface of the test piece. A parallel beam of light, obliquely incident on the surface was reflected on to a screen. The reflected beam, due to the agitation set up in the liquid by the excited test piece, assumed various structures depending upon the metal under investigation. Photographs of the oil vibrations on the surface of the sample are shown in Figs. 7(*a*) and 7(*b*). The pattern of the reflected light gives a means of detect-

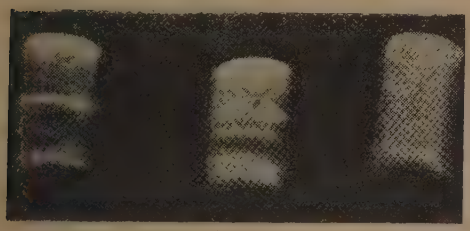


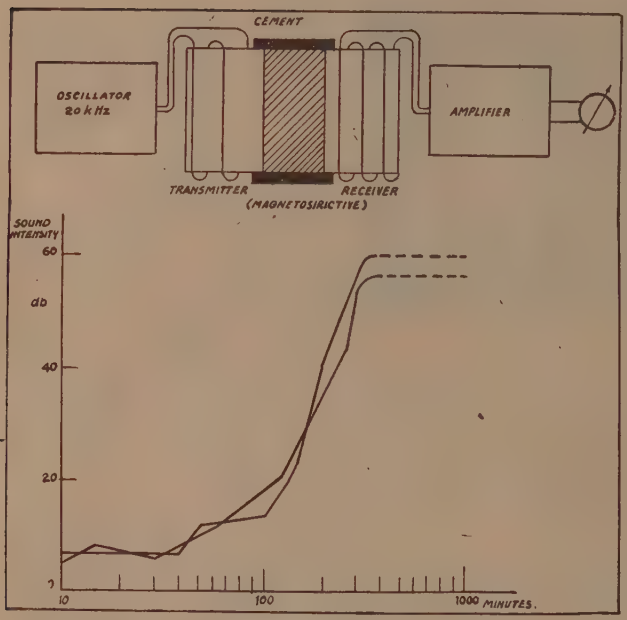
Fig. 7 (b).—Detection of Inhomogeneity in the material under test (Sokoloff).

ing the inhomogeneity (due to cracks, fissures and crevices) of the material under test. The samples tested by Sokoloff included steel and bronze discs 220 mm. in diameter and from 30 to 50 mm. in thickness ; a cast iron cylindrical block 200 mm. in diameter and 120 mm. in height, steel cylinders 100 mm. in diameter and 100, 200, 250 mm. in height ; and brass cylinders 80 mm. in diameter and 100 mm. in height. He could detect cracks having a thickness as small as 0.0005 cm. By applying more powerful oscillations and using more sensitive methods of detection of elastic vibrations, it should be possible to fluoroscope metals much thicker than 1,000 mm.

It is not claimed that this method of investigating metals can entirely replace the X-ray technique but it is valuable in the examination of metal blocks of great thickness, and also in the determination of chemical compositions, etc. As there is no need to take photographs of every sample (as is the case in the X-ray method,) a very large number of metals can be examined in a shorter time and less expense. Behr[33] and Shrayber[34] have recently extended Sokoloff's work and have been able to measure the inhomogeneities in various metals caused by slag formation, blow holes, or potential cracks. Trost[35] has developed an apparatus for the rapid and continuous detection of doublings in steel sheets. Water is used as the coupling link between the oscillating quartz, the sample to be tested and the detector which is capable of indicating the minutest oscillations passed through the metal sheets.

Inhomogeneity in Ferro-Concrete Structure.—Ultrasonic waves have also been used for detecting cracks in ferro-concrete structures and rods. Meyer[36] employed them in confirmatory observations on the dynamic elasticity modulus and damping constants of such rods. Two ferro-concrete rods apparently perfectly alike but having different bending oscillations, namely, 50 and 35 cycles per second, caused some doubt that one of them had developed inhomogeneity due to a hair crack. A supersonic transmitter and a piezo-electric detector were attached to the fixed surface of the rod. The first rod which was apparently whole having an oscillation of 50 cycles per second, showed good sound conduction, while the other having an oscillation of 30 cycles per second gave an amplitude which was only 2 per cent. of the former. By moving the detector along the defective rod, the positions of the hair cracks could be mapped by measurable changes in amplitude.

High frequency sound waves can be usefully employed for studying the sedimentation and setting of cement. The apparatus given in Fig. 8(*a*) was employed by Meyer for this purpose. A special mixture setting in about 12 hours was poured into the gap between the transmitter and the detector. During the first hour of settling there was only a slight transmission of sound but in the final stages, the energy



Figs. 8 (*a*) and 8 (*b*).—Transmission of Supersonic Sound in Setting Cement (Meyer).

transmitted was 10^6 times as much as in the beginning. The variation of the intensity, when plotted against time, gave a curve (*vide* Fig. 8(*b*)) which showed how the cement progressively adhered to the iron plates; the closer the contact the better the sound transmission.

Tyre Testing.—The Goodyear Tyre and Rubber Company[37] have developed a supersonic tyre tester for detecting hidden separations within tyres. The tyre to be inspected is hung on two rollers in such a way that the bottom portion passes through a shallow tank of water in which ultrasonic waves are generated by a magnetostriction oscillator. The vibrations are transmitted through the tyre to a microphone immersed in a small quantity of water within the tyre. The detection of separation depends on the reflection of the highly directional ultrasonic waves at a rubber-air interface. The amount of opening is immaterial for its detection, a very thin air film or an unusual amount of porosity is sufficient. A check on the sensitivity and performance of the device is readily made by attaching to the tyre surface a sandwich composed of two thin sheets of rubber cemented together around the edges. Only a few minutes are required for the test. The method is of particular value in eliminating waste and inefficiency in the retreading of defective tyres especially those of large trucks and buses.

Physico-Chemical Effects

Emulsification and Colloidal Dispersion.—Using an ultrasonic generator of high power (2 kw.) and a frequency of 300,000—400,000 cycles per second, Wood and Loomis[9] showed that immiscible liquids like benzene and water could be emulsified. Sollner[38] and Sollner and Bondy[39] found that the phenomenon of "cavitation" plays an important part in emulsification. They also showed that the resulting emulsion differed according as a gas like air or nitrogen was present as a third phase or not. Similarly, using a frequency of 400,000 cycles per sec., Rschevkin and Ostrowsky[40] brought about the emulsification of mercury, tin, bismuth, lead, copper and silver in water. The particle size of the metals was as small as 10^{-6} cm. Claus and Schmidt[41] investigated the dispersion of metals by ultrasonics during electrolysis. They found that if the cathode is exposed (during electrolysis) to intense ultrasonic radiation, the metal deposited on it is flung out into the liquid in a very highly dispersed form. The degree of dispersion of metal depends both on the nature of the metal and the intensity and frequency of the supersonic waves, thereby providing an elegant means of controlling the particle size of the dispersed metal. Practically all the metals which can be separated by electrolysis can also be dispersed. The method is likely to acquire great industrial importance in the manufacture of catalysts, sols, and other chemical or pharmaceutical preparations. A photomicrograph of dispersed metals by ultrasonics during electrolysis is shown in Fig. 9.

Photo-chemical Effects.—Claus[42] extended his experiments to photographic emulsions. His investigations showed that both homogeneity and stability of the emulsions can be improved by the action of supersonic

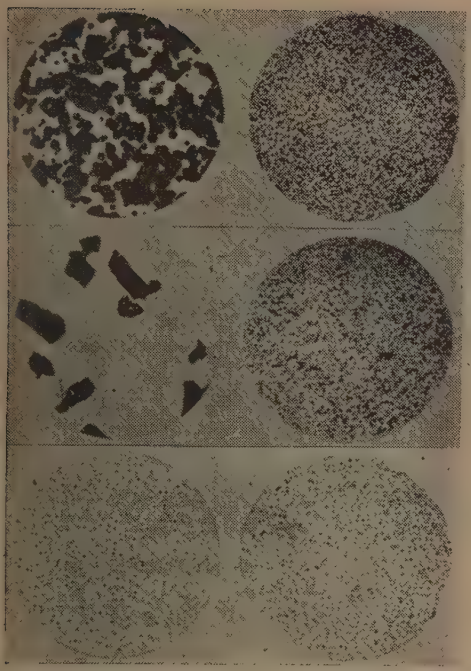


Fig. 9.—Photomicrographs of dispersion of metals during electrolysis by supersonics (Claus).

waves of high frequency. He further observed that the injurious formation and accumulation of grains in the photographic plates can be almost completely eliminated by this means. The colour sensitivity of the plates can be considerably improved by dispersing the dye in the emulsion under the influence of ultrasonic waves of fairly high intensity because a greater fraction of the dye will be utilized for colouring the grains. In virtue of the small size of the grains, the resolving power of treated emulsion is greatly increased. The technical importance of the treatment lies in the fact that it is not necessary to subject the emulsion to the tedious process of washing; considerable saving of time and money is thus effected. Further, since no foreign substance is added to the emulsion-base, the durability of the films is greatly enhanced. Dangers[43] investigated the photographic properties of such emulsions and found them to be far superior to those prepared by the more usual methods of chemical peptisation. Photomicrographs of emulsions prepared by the application of ultrasonics* are shown in Fig. 10(*a*).

Marinesco and Trillat[44] exposed photographic plates to very high frequency supersonic waves (428 to 1,435 thousand cycles per second) and found a slight blackening of the pictures as shown in Fig. 10(*b*). Later on Marinesco and Reggiani[45(b)] obtained a system of fringes on a silver bromide gelatine photographic plate, placed in a light-proof case filled with a developer and exposed to a beam of stationary supersonic waves having a frequency of 717,000 cyeles per second.

Action on Highly Polymerized Molecules.—Szalay[46] has investigated this problem in detail. By using ultrasonic waves of 700,000 cycles per second he was able to break a number of highly polymerized compounds into their elementary constituents. Thus starch was broken down to dextrin, and cane-sugar into mono-saccharides. The mechanism of depolymerization by supersonics is still unexplained. Demann and Asbach[47] studied the chemical effects of supersonics in the range, 2×10^4—5×10^6 cycles per sec. ; they found that the rate of polymerization and condensation reactions can be considerably accelerated by this

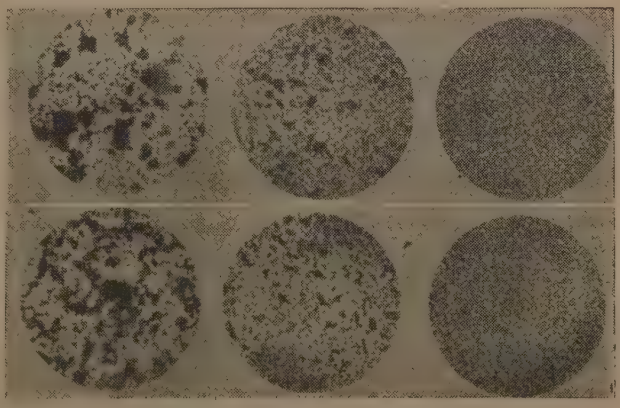


Fig. 10 (a).—Photomicrographs of emulsion of silverbromide and gelatine (Claus).

*Protas[45] (*a*) has recently pointed out that the results obtained by Claus are attributable to the heating in the silver halide emulsion.

Fig. 10 (b).—Blackening of Photographic plates due to supersonics. (Marinesco and Trillat).

treatment. The yields obtained were also greatly improved. The reaction could be so directed that undesirable side reactions were either reduced or entirely suppressed. The treatment, however, could not change the direction of the reaction, i.e., it was not possible to produce depolymerization under conditions which favour polymerization or condensation.

Liquefaction of Gels.—Marinesco[48] and Freundlich, Rogovski and Solloner[49,50] found that thixotropic gels, e.g., iron and aluminium hydroxides, were liquefied when placed in a field of high intensity ultrasonic waves. They also found that swelling and peptization of gels are accelerated by the action of supersonics. The rate of solution of rubber in aniline and ether is considerably increased by irradiation with supersonic waves.

Change in Reaction Velocity.—The reaction velocity of a number of chemical processes is enhanced under the influence of ultrasonics. Richards and Loomis[51] found an increase in the rate of hydrolysis of dimethyl sulphate and of the oxidation of potassium iodide. Bethue[52] also found similar results in the case of oxidation of potassium iodide and was able to separate iodine by a ten minute "dose" of ultrasonics. Bhar[10] conducted experiments with similar results. By successive exposures, he was able to extract 90 per cent. of the iodine which was removed (as soon as it was released from potassium iodide) by activated charcoal. Iodine was later recovered from charcoal by sublimation. Shmitt, Johnson and Olson[53] have obtained similar results. They were also able to separate sulphur from hydrogen sulphide by the oxidation effects produced by ultrasonics.

Petroleum Technology.—Ultrasonics find application in Petroleum Technology[54]. The stable water-in-oil emulsions can be de-emulsified; carburation in internal combustion engines can be improved; impurities present in lubricating oils can be coagulated; asphaltene removing action of sulphuric acid can be enhanced and cracking and hydrogenation of petroleum can be improved by the agency of ultrasonics. The effective octane value of an engine fuel is known to be raised by the injection of water vapour into the engine. The apparatus required for this purpose is weighty and cumbersome. Attempts have been made to use emulsified fuels which have formed the subject of various patent specifications. Chemical and mechanical emulsifying agents can be successfully replaced by ultrasonic vibrations and it is possible to secure stable water-in-oil emulsions which will greatly augment the octane number of the fuel. It must be admitted, however, that ultrasonic vibrations suitable for emulsification should have considerable energy but it is quite likely that the more recent developments in the methods of generating wide ranges of frequencies and improvement in the technique of application of vibrations to liquids, will ultimately solve the difficulty.

Supersonics in Metallurgy

As in the case of immiscible liquids, a number of metals which are immiscible in the liquid state, can be brought together and alloyed by ultrasonic waves. Thus iron-lead, aluminium-cadmium, aluminium-lead, copper-lead, and zinc-lead which are not miscible ordinarily in the liquid state in any proportion are emulsified when exposed to supersonic waves of high intensity. According to Hertl[55], it is possible to keep the melt mixed to the moment of solidification under the influence of ultrasonic waves, whereby the solid alloy acquires a fine structure: Masing and Ritzau[56] have succeeded in getting lead alloyed with aluminium. Sokoloff[57] also investigated the action of ultrasonics on metallic melts of zinc, tin, and aluminium, and found that

the melts under this treatment solidified more quickly. A few photomicrographs of cast zinc obtained by him are shown in Fig. 11. The frequency used was 6×10^5—4.5×10^6 cycles per second and the power

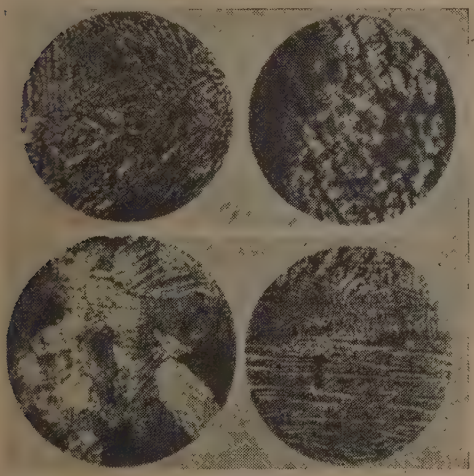


Fig. 11.—Photomicrographs of cast zinc under the influence of ultrasonics (Sokoloff).

about 80 watts. More recently, supersonic waves have been employed for removing oxide films from aluminium as a preliminary to tinning[58]. The aluminium sheets are first immersed in a bath of molten metal which is irradiated by sound waves of 12,000 cycles per second and 10 watts intensity. This subjects the contacting particles to accelerations and deaccelerations of the order of 100 gms. and destroys the oxide film, thus enabling the zinc particles to be anchored on to the sheet.

Experimental investigations on the behaviour of melts by Behr[59] have revealed that ultrasonic vibrations have a marked effect on the grain refining of antimony and cadmium ; he found that the grain boundary disappeared in the case of duraluminium. Ultrasonics find practical application in welding for grain refining and for improving the properties of the weld metal. Promising results have been obtained by the application of ultrasonics to spot welding. Gases absorbed by light metals (e.g., aluminium and tin) and their alloys during the process of solidification greatly impair their strength and ductility. Esmarch, Rummel and Buther[60] have developed a technique of degassing these metals and their alloys during solidification. By the application of supersonics, degassing is completed in about half an hour.

The crystalline structure of ferro-magnetic materials is loosened by ultrasonics[61]. Mahoux[62,63] utilized this property for hardening steel by speeding up the diffusion of nitrogen into the metal.

Ceramics

In the purification of white ware clays and in some types of clay slip casting, it is essential to disperse the clay in water to its ultimate particle size or at least to a finer particle size than is possible with the electrolyte alone. By using ultrasonic waves generated by a magnetostriction generator, Bole and Loomis[64] showed that a higher degree of dispersion can be secured in the case of white ware clays. Clay slips, which have already been dispersed with electrolyte can be further dispersed to a finer particle size under the influence of ultrasonic vibrations of about 20,000 cycles per second. The vibration treatment alone, without the electrolyte, did not reduce the particle size any farther than that effected by the electrolyte. A combination of electrolyte and ultrasonic treatment resulted in a higher dispersion than that brought about by either of them. A much finer clay suspension appears possible by using frequencies of the order of a million cycles per second generated by piezo-electric crystal.

Biological and Medical Research

The biological effects of ultrasonic waves have been investigated by a large number of workers. Wood and Loomis[9] found that small animals like fish and frogs were either lamed or killed in the ultrasonic field (Fig. 12). Red blood corpuscles are destroyed. Harvey and Loomis[65] observed that the cells which are round got distorted and stretched when subjected to ultrasonic waves, losing their colour and finally breaking up into a number of small spherical particles. The effect of ultrasonics on the hearts of cold-blooded animals varies[66] with the animals. Similarly in the case of bacteria and pathogenic organisms the effects vary. In some cases an increase in agglutination is observed ; there is also a diminution in virulence. Yeast cells lose their power of reproduction and luminous bacteria their luminosity. A few important applications of ultrasonics in the field of medical research have been described,

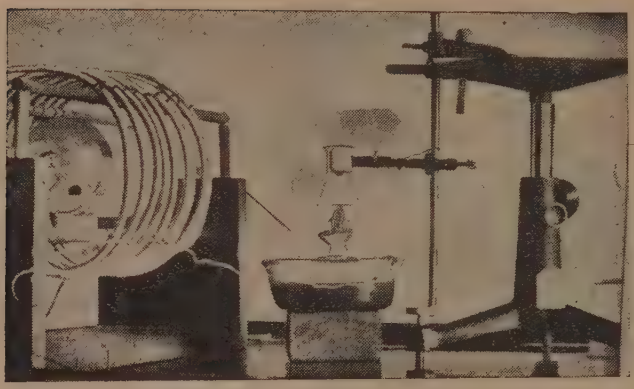


Fig. 12.—Biological effects of supersonics (Wood and Loomis).

notably by Chambers[67]. His findings are of great value in immunology. Under the influence of high frequency sound waves, bacterial cells in cultures, appear to burst and release the antibodies, the milky medium becoming translucent, as a result of the treatment. The cell walls of the bacteria can then be separated by high speed centrifuging. By employing this technique and injecting the cell-free fluid after sterilization, Chambers obtained encouraging results in the treatment of infections due to typhoid and hæmolytic bacilli. Flosdorf and Chambers[68] studied the changes produced in albumin by ultrasonic radiation and have discussed the bearing of these changes in the field of immunology. Chambers[67] employed supersonic waves of great intensity in giving to milk, what is known as a "soft curd" characteristic, and thus rendering it suitable for the feeding of infants and convalescents recovering from gastro-intestinal disorders. Supersonic waves have also been used for disinfecting milk[69]. By this treatment the bacterial count of milk can be reduced by 99 per cent. in 45 minutes. A special apparatus for the continuous treatment of milk has been described, in which the milk stream is made to pass through a region in which the ultrasonic energy is concentrated. This process has been employed on a commercial scale.

Supersonics of very high frequency are now being tried for the treatment of ulcers[70]. Waves with a frequency exceeding 300,000 cycles per second are being employed for the study of the pathology of cancer cells in the hope that the treatment would be ultimately helpful in destroying selectively the cancer cells. The efficiency of sulpha drug therapy in wound treatment has also been found to be enhanced by the application of supersonics[71].

Freundlich, Sollner and Rogowski[72] have suggested the application of ultrasonics for diathermy. They have shown that the marrow of the bone can be heated without the bone itself being affected. Further experiments are required for establishing the value of deep ultrasonic therapy.

Vernalization

Extensive experiments have been carried out in Russia on vernalization of seeds and tubers by irradiation with ultrasonics. The treatment induces earlier sprouting and the yields are also greater.

Miscellaneous Effects

Ultrasonic radiations have the effect of accelerating crystallization of super-saturated liquids[73], coagulation of smoke, dust and mist[74], etc., lowering the boiling point of carbon-tetrachloride[75], ether and water, improving the efficiency of fractional distillation, reducing the viscosity of colloidal solutions of gelatine, agar-agar and gum-arabic[73], promoting the explosive evaporation[76] of superheated liquids, splitting of hæmocyanin molecules[77] and helping the dispersion of soil colloids. Wood[78] found that soil colloids were completely dispersed in water by a few minutes' exposure to ultrasonic waves while by the usual process, the shaking and centrifuging operations had to be repeated 20 to 30 times before the colloid was completely dispersed. Porter and Young[79] found that under the action of ultrasonics, molecular rearrangement is brought about in the case of benzazide in aniline and benzene solutions at 25° C. Barret and Porter[80] have extended this work and by employing a wide range of frequency (478×10^3—16.275×10^6 cps) and power (110—250 watts) found that rearrangement is proportional to the energy of the vibrations but independent of the frequency.

Supersonic waves find some application in the textile industry too. The dyeing properties of dye suspensions is considerably improved by exposure to supersonic radiation. Thus when indanthrene green G.G. is

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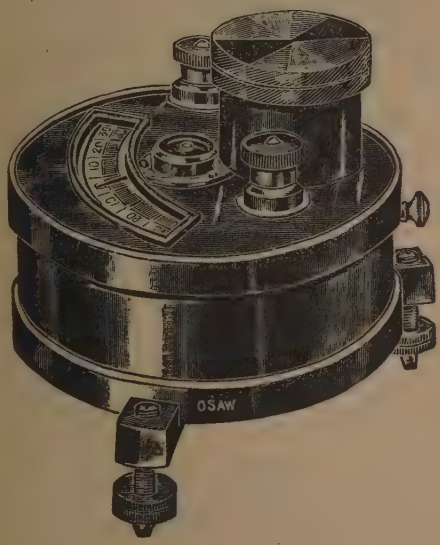

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exposed to the action of ultrasonic waves for 15—60 minutes the size of the dye particles is reduced to 1 to 2μ (see Morozov and Milinskayo[81]). Turmanski and Makisimore[82] found that higher dispersions of indanthrene pigments can be secured with the aid of supersonics than that obtained by the use of a colloid mill.

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2 Hidemann, E., *Arch. fiir des Eisenhuttese Weten*, 1938, **12**, Part 4.
3 Bergmann, Von L., *Der Ultraschall.*

FOOD AND AGRICULTURAL ORGANIZATION

THE Government of India have accepted the constitution of the permanent *Food and Agricultural Organization* (F.A.O.) of the United Nations, drawn up by the United Nations Interim Commission appointed in July 1943, to prepare for submission to Governments, a specific plan for a permanent International Organization for Food and Agriculture as recommended by the Hot Springs Conference.

The broad objectives of the "F.A.O.", as set forth in the Preamble to the Constitution, are

(1) to raise the levels of nutrition and standards of living among the peoples of the world,

(2) to secure improvements in the efficiency of the production and distribution of all food and agricultural products,

(3) to better the conditions of rural populations, and

(4) to contribute by these means towards an expanding world economy.

The member nations undertake to report to one another through the "F.A.O." on the measures taken and the progress achieved in these fields of action.

The methods to be employed by the "F.A.O." are indicated in Article I of the Constitution, which outlines the functions of the Organization:

(1) The Organization shall collect, analyse, interpret and disseminate information relating to nutrition, food and agriculture.

(2) The Organization shall promote and, where appropriate, shall recommend national and international action with respect to

(*a*) the scientific, technological, social, and economic research relating to nutrition, food and agriculture;

(*b*) the improvement of education and administration relating to nutrition, food and agriculture, and the spread of public knowledge of nutritional and agricultural science and practice;

(*c*) the conservation of natural resources and the adoption of improved methods of agricultural production;

(*d*) the improvement of the processing, marketing, and distribution of food and agricultural products;

(*e*) the adoption of policies for the provision of adequate agricultural credit, national and international;

(*f*) the adoption of international policies with respect to agricultural commodity arrangements.

(3) It shall be the function of the Organization

(*a*) to furnish such technical assistance as Governments may request;

(*b*) to organize, in co-operation with Governments concerned, such missions as may be needed to assist them to fulfil the obligations arising from their acceptance of the recommendations of the United Nations Conference on Food and Agriculture; and

(*c*) generally to take all necessary and appropriate action to implement the purposes of the Organization as set forth in the Preamble.

The F.A.O. will include in its scope, forestry and fisheries as well as agriculture. It will be concerned not only with food but with non-food agricultural products, such as fibres and oils, and with the primary products of forests. Nutrition as well as the production, processing and marketing of foods will lie within its field of activity.

NOTES AND NEWS

Synthesis of Vitamin C

THE method employed in the first synthesis of vitamin C involved the following steps:

Galactose → Galacturonic acid → *l*-galactonic acid→*l*-lyxose→*l*-lyxosone→Addition of HCN followed by hydrolysis and rearrangement→ Vitamin C. The method has not been commercially practical.

Alternative methods of vitamin C synthesis are continually under investigation. The starting material suggested in a recent process is beet pulp which contains about 30 per cent. galacturonic acid. By treating the pulp, suspended in water, with pectase, galacturonic acid which is released from the pectins goes into solution, and can be separated by precipitation as sodium calcium galacturonate, which can be readily crystallized. (*Chemical Age*, 1944, **51**, 35.)

The conversion of sodium calcium galacturonate into vitamin C is accomplished as follows :—The uronate is reduced by hydrogen with Raney nickel catalyst to sodium and calcium *l*-galactonates. After converting the salt to *l*-galactone-galactonate, it is oxidized by sodium chlorate in the presence of vanadium pentoxide by the method of Pasternack and Regna, to methyl 2-keto-*l*-galactonate. Treatment of the methyl ester with sodium methylate gives sodium ascorbate from which crystalline vitamin C can be readily obtained. The yield is approximately 20 per cent. of the theoretical. On the basis of beet pulp, the yield is about 50 lbs. of vitamin C from one ton of dry pulp.

Recovery of Tartarates

Experiments carried out by the U. S. Department of Agriculture in its *Western Regional Research Laboratory*, have conclusively established the commercial feasibility of utilizing Amberlite IR-4, an anion exchange resin developed by the *Resinous Products and Chemical Co.*, of Philadelphia, for the recovery of valuable tartarates from grape winery waste liquors. By using the base exchange resin, it is possible to recover 85 per cent. of the tartarate which was formerly going to waste. (*Chem. Age*, 1944, **51**, 130.)

Tartarate is present in brandy-still slops in dilute solution and is accompanied by large amounts of extraneous materials including acids, salts, pigments, and colloidal matter. By passing the liquor through a bed of the exchanger, the tartarate remains fixed to the resin, while the accompanying impurities pass through as a waste. When the exchanger bed has accumulated a capacity load, a solution of sodium chloride is passed through it to remove the tartarate as sodium tartarate of about 5 per cent. concentration. The washing also serves to prepare the resin bed for a second absorption cycle. The tartarate is precipitated as calcium tartarate and is thus obtained in a concentrated form and in a high degree of purity. The process is economical. It is found that the resin bed can be used repeatedly and tests have shown that even after 150 exchange cycles, the operating efficiency of the resin is hardly impaired.

New Acetic-Acid Process

One of the most important applications of boron trifluoride as a catalyst is in the new synthetic acetic and propionic acid process of the du Pont Company. The catalyst is actually used in the form of a hydrate. The process is essentially a condensation of carbon monoxide with methanol or ethanol under pressures as high as 900 atmospheres at 260° C. Yields of 79 per cent. for acetic and 50 per cent. for propionic acid are reported. (*C. T. J.*, 1944, **115**, 129.)

Electro-Deposition of Copper Powder

In a report before a meeting of the *Electro-Chemical Society of Milwaukee* in April, W. H. Osborn and S. B. Tuwinor of the *Phelps Dodge Corporation, Laurel Hill, N.Y.*, described their attempts to produce copper powder in a standard electrolytic copper refinery. The investigators set out to retain the same current density, electrolyte composition and temperature which had been proved optimum for most economic refining practice. The same impure refinery anodes were to be used, allowing slimes to collect at the bottoms of the tanks for intermittent removal. Electrolyte circulation was to be maintained at the rate customary in copper refineries. It was hoped that by a substitution for the oil used in preparing the brittle cathode, a deposit of copper powder might be obtained.

The method finally preferred was the application of castor oil previously oxidized with a small amount of perchloric acid to a rolled sheet anode followed by the electro-deposition of copper as a powder, using the same equipment and electrolyte employed in the multiple system of copper refining. (*Iron Age*, June 1944.)

The investigation resulted in the discovery of a crystalline metallic deposit having the following characteristics: Particles are flakes, each being a single or twinned crystal, arranged in the deposit to form a cellular structure with many voids. Individual flakes are about 1 micron thick. Each flake is coated with a film of oil which was applied to the cathode sheet. Copper particles grow in two dimensions only. For some reason, probably selective wetting by the oil, growth was impeded in the third dimension. The powder produced by this method is not suitable for the usual sintered metal products because of its flow characteristics and the copper particles being coated. However, this type of electrolytic flake copper powder is ideally suited to further processing either by ball milling, obtaining a very fine grade of bronze powder which is especially useful in anti-fouling compositions.—*U. S. O. W. I., Mining and Metallurgical Engineering News Letter, No.* 3.

T.V.A. Prefabricated Houses

Prefabricated houses such as those used by T.V.A (Tennessee Valley Authority) for workers on the Fontana Dam in North Carolina may be the model for houses for the quick rehabilitation of bombed-out British cities. According to Prime Minister Winston Churchill's recent broadcast, his Government is considering the adoption of a similar type of dwelling to replace war-damaged or destroyed

homes, now estimated at more than a million family dwelling units. Mr. Churchill's statement apparently resulted from the report of a British commission which has been studying American prefabrication methods. (*Engineering News Record*, June, 22, 1944.)

The commission reported that "if it should be necessary immediately after the war in Europe to build in this country a number of factory-produced houses of temporary character so that the most urgent demand for accommodation may be met without undue delay, we would draw your attention to the stressed skin plywood houses we saw being manufactured for the Tennessee Valley Authority. Though they are designed for a life of a few years only, we were informed that these houses, with reasonable attention, would remain in good condition for as long as 10 years. The houses are composed of two or more sections each measuring 8 ft. (2.45 m) in width and 24 ft. (7.30 m) in length.

T.V.A. prefabricated houses now include dwellings with one, two or three bedrooms, complete with finished painting, plumbing, wiring, fixtures and specified furnishings. The units are factory-built and have been delivered long distance by trailer. Five men can put up an average two-section house in two or three hours after the foundations have been prepared. Assembly is simplified by bolting sections together.—*U. S. O. W. I., Civil Engineering News Letter No.* 2.

Electric Power Development in India

"The Government of India have decided to constitute a *Central Technical Power Board* which will act as a Central Planning Organization and will advise the Central, Provincial and State Governments as regards encouraging, planning and pressing forward the widespread development of public electricity supply throughout the country," says a Press Note dated 7th November 1944, "the Board will be a strong technical organisation designed to collect ideas, conduct surveys and prepare outline schemes for electrical development in consultation with Provincial and State Governments."

The basic function of the Board will be to collect material relating to power resources and study and plan schemes for power utilization so as to bring about improvement in the national economy, particularly in those zones where the scope for development of electricity supply seems to be promising but where no active planning appears to be in hand. Thus in consultation with the Provincial or State Governments it will undertake investigations, conduct surveys, prepare technical schemes and supply an appreciation of the effect of the scheme on the general economy of the region. The results of the surveys, planning and estimates will form a "Project Report."

"The Board will also assist Provincial Governments and States in regard to rural electrification and encourage the development of power irrigation and rural electrical development where such schemes can be expected to assist the economic condition of the agriculturists and rural communities. It is intended to become the central authority responsible for the load direction and collation of hydro-graphic surveys throughout India on a recognized standard basis. In carrying out this work the Board will encourage Provincial and State Governments to develop their hydro-graphic surveys, and will assist them by supervising their survey methods. Other functions of the Board will be: to review and lay down for the whole of India standard voltage and practices for generation, transmission and distribution of electricity; to initiate the broad lines of research programmes desirable for the requirements of the special conditions of electric power development in India, to initiate propaganda for the education of the public in the uses of electricity and to initiate and devise schemes for the training of Indian engineers in the specialized field of public electricity supply.

"The Board's organization will be divided into four sections—Power System Planning, Power Utilization, Public Relations and Propaganda and Secretariat. The Power System Planning Section will cover subjects relating to hydro-power station sites, hydro-electric surveys, etc., power transmission and thermal power station investigations. Similarly, the Power Utilization Section will deal with power requirements of and supplies to electro-chemical and metallurgical industries, industrial power and mining, rural electrification and power irrigation, and standards, research and the development of electrical manufactures.

"The Board will consist of a Chairman, two full-time members, three part-time members and a number of ex-officio members. The Chairman will be the Electrical Commissioner with the Government of India. The headquarters of the Board will be at Calcutta for the present and, along with clerical establishment, it will have a staff of engineers."

Sub-soil Irrigation

The Government of India have decided to constitute a Sub-soil Section under their Irrigation Adviser. The section will be provided with trained staff and equipment. It will serve the following objects:—

(*a*) to advise Provinces and/or Indian States, if so desired, in regard to the selection of suitable tracts for tubewells for irrigation;

(*b*) to carry out trial borings when required for deciding the sub-soil "aquifers" in doubtful areas;

(*c*) to maintain a limited quantity of essential equipment, e.g., casing pipes, draw pipes, strainers, motor-pumps, percussion boring sets, compressor and hydraulic boring rigs for (*b*) above;

(*d*) to advise on the organization of irrigation on approved lines as established by long experience in the United Provinces and elsewhere, and

(*e*) to collect and co-ordinate the data now available in the United Provinces and (to some extent) elsewhere in regard to
  (i) Sub-soil supplies in various alluvial doabs;
  (ii) Irrigation demand for different crops in various climatic conditions, and
  (iii) Water rates current in different localities.

The Sub-soil Water Section will be under the Deputy Irrigation Adviser, who will be assisted by an Assistant Engineer, three overseers and other trained personnel. The total expenditure of this section is estimated at Rs. 2,27,000 non-recurrent and Rs. 51,000 per year recurrent.

Coconut Committee, Travancore

The Travancore Coconut Committee Act (Act VIII of 1120) which was recently passed, provides for the creation of a fund for the improvement and development of the cultivation, marketing and utilization of coconuts in the State and the levy, for that purpose, of an excise duty not exceeding 4 annas

per cwt. on all copra consumed in any mill in the State, whether such copra is produced in the State or is imported from outside it. The Coconut Committee to be constituted under the Act will promote the improvement and development of the cultivation of coconuts and their utilization, by undertaking or assisting industrial, technological and economic research, supplying technical advice to growers, introducing improved methods of cultivation, grading copra and its products, and by other means.

Inter-University Board

The **Inter-University Board** which met at Patna on 2nd December 1944, decided to reorganise itself in view of the expansion of its work and to locate the office of the *Board* permanently at one place, preferably at Delhi.

The *Board* elected Sir Maurice Gwyer to be Chairman and Prof. K. P. Sinha to be Secretary.

In view of the limited resources available in the country for advanced study and research in various subjects, the *Board* considered it desirable, by a resolution, that students should be permitted to migrate from one university to another and that research courses such as Ph.D., D.Litt., D.Sc., should be open to graduates of other universities, with such restrictions as might be imposed by individual universities.

Conference of Chemical Manufacturers

The Conference of *Manufacturers of Chemical and Pharmaceutical Products* and Representatives of Universities and Research Institutions, held at Calcutta on the 11th December 1944, adopted a resolution urging the establishment of industrial research departments in every university and research institution with adequate financial aid from the State and industrialists. This research, in its opinion, should be carried out under the guidance and control of Research Councils comprising representatives of the industry and scientific experts.

Mr. N. R. Sarker, who presided over the *Conference*, stressed the necessity of setting up a machinery of collaboration between research and industry, the absence of which had resulted in many valuable researches carried on in the universities and scientific institutions being neglected. If properly utilized, such a machinery, he said, would have considerably added to the wealth and welfare of the country.

Alluding to the pharmaceutical industry, Mr. Sarker said that the industry had considerably developed as a result of the war but it was still suffering from some grave disadvantages which would have to be removed. In the first place, basic chemicals were not obtainable in India at a reasonable cost; secondly, the solvent industry on which the drug industry depended, was in an unorganized state; and, thirdly, the coal-tar industry was undeveloped. If India was to develop her drug industry it would be necessary to tackle these questions.

The Indian Drugs Research Association

A research organization, under the name "The Indian Drugs Research Association, Poona" has been sponsored by a group of scientists. The aims of the Association, among others, are (*a*) to collect and cultivate knowledge about Indian drugs, (*b*) to undertake biological, chemical, pharmacological, pharmaceutical and other scientific investigations, (*c*) to collect and cultivate medicinal plants in India and to maintain a museum and garden, and (*d*) to maintain laboratories, hospital and a library. The sponsors have succeeded in enlisting the support of a large number of enthusiastic scientists, among them the Agricultural Chemist and the Economic Botanist of the Government of Bombay. The Association is not a commercial institution and it seeks to expend its income derived from subscriptions, donations, etc., for pursuing scientific research. There is a vast field in this country—little explored by modern science—for drug research and we wish the organization every success. Communications and inquiries relating to the Association should be addressed to The Honorary General Secretary, 631/27, Sadashiv Peth, Poona 2.

Nobel Prize Awards, 1943 and 1944

Physics: 1943, Prof. Otto Stern of the Carnegie Institute of Technology, Pittsburg, Pennsylvania, for his contributions to the study of atomic beams and the discovery of the magnetic momentum of the proton; 1944: Prof. Rabi of Columbia University, New York, for his "resonance method for the registration of magnetic qualities of the nucleus of the atom": **Chemistry:** 1943, Prof. George von Hevesy of Stockholm for his outstanding work in the use of isotopes as indicators in the study of chemical processes. The award for 1944 has been held over until next year.

Bank of England Trust Fund for Research

To mark the 250th anniversary of the founding of the Bank of England, the Court of Directors have decided to establish a trust fund with a capital of £100.000 for the promotion of economic research. The fund will be named after Sir John Hoblon, the first Governor of the Bank (1694), and Mr. Montague Norman who has just retired from the Governorship. The proceeds of the fund will be utilized for the promotion of research into the "working and function of financial and business institutions in Great Britain and elsewhere and the economic conditions affecting them." The management of the fund will be entrusted to a Board of Trustees, which will be independent of the Bank. The trustees will award scholarships, probably three in a year, tenable in any of the British universities.

Announcements

New Year Honours.—The following awards, among others, have been gazetted:—

Knighthood.—Mr. R.W. Targett, Director-General, Supply and Disposals, Department of Supply, Government of India; Mr. B. J. Wadia, Vice-Chancellor, University of Bombay; Diwan Bahadur A. Lakshmanaswami Mudaliyar, Vice-Chancellor, University of Madras; Mr. C. W. B. Normand, Officer on Special Duty, India Meteorological Department; Mr. J. J. Ghandy, Agent, Messrs. Tata Iron and Steel Company, Ltd.

Diwan Bahadur.—Mr. K. R. Pai, Controller of Patents and Designs, Government of India.

At the meeting of the **Indian Lac Cess Committee**, held at Calcutta in July 1944, it was decided to appoint a Lac Information Officer for India for the purpose of unifying the publicity, propaganda and demonstration work of the *Indian Lac Research Institute, Namkum*, and for establishing trade contacts within the country.

Science in the Assembly

Manufacture of Locomotives

"It has been decided to develop the Kanchrapara shops of the Bengal Assam Railway for the manufacture of locomotives as soon as possible after the war and the preliminary work was in hand," said the Railway Member in reply to Mr. Lalchand Navalrai in the Central Assembly on 2nd Nov. 1944. "In addition," he said, "arrangements are being made to provide at the East Indian Railway shops at Singhbhum, additional machinery for the manufacture of 100 boilers per year as a war measure and of 50 locomotives and 50 boilers as soon as possible after the cessation of hostilities. *Messrs. Tatas* are not yet ready to undertake the manufacture of locomotives but have expressed a desire to take it up as a post-war development. Negotiations with *Tatas* have not yet been finalized."

The War Transport Member informed the same member that orders have been placed for 225 broad-gauge and 377 metre-gauge locomotives against the programme of 1944-45 and that contracts up to 30th Sept. 1944 totalled 48 broad-gauge and 174 metre-gauge locomotives. These were obtained on Lend-lease from the United States.

Rice Research Fund

The Assembly took up (on 8th Nov. 1944) Mr. Tyson's motion for reference to a select committee of his Bill to provide for the creation of a fund to be expended by the Committee for the improvement and development of cultivation and marketing of rice. In the course of the debate, Mr. Tyson, explaining the provisions of the Bill, pointed out that funds for the Committee should be provided by the levy of a small excise duty not exceeding 6 annas per ton on all paddy milled in power mills. Only 27 per cent. of the rice produced in India was so brought to the mills and the cess worked out to less than one pie per maund or one anna per annum to each rice-eating member of a family. It is expected to raise Rs. 54 lakhs a year this way, which was twice the income of the *Imperial Council of Agricultural Research*. He added that proposals were circulated to all Governments, and all except Bihar approved them.

Dr. Bannerji opposed the levy of a cess on rice and declared that rice being the most important staple food in the country, the Government should spend the money themselves on research. Mr. N. G. Ranga moving an amendment asking for circulation of the Bill till January 1946, observed that the Government should withdraw the present measure and bring forward a more satisfactory one. After two days of discussion, the Government agreed to circulate the Bill proposing the constitution of a *Rice Cess Committee* for public opinion.

Opening of New Collieries

In reply to Mr. K. C. Neogy during question time, on 15th November, the Supply Member said that fourteen new coal mines had been opened, most of them in Bihar and Bengal.

Indian Textile Production

Replying to Mr. K. C. Neogy on 16th Nov. the Commerce Member said that the total production of cotton textiles in India in the current year would be about 6,300 million yards and that if all went well, the figure would increase to 6,500 million yards next year. Of this about 1,500 million yards was handloom production and the rest mill production. Not more than 900 million yards will be taken up for the defence services and another 600 for civil exports.

Handloom Board

"The formation of an *All-India Handloom Board* to advance the interests of handloom industry was under Government consideration," said the Commerce Member during the question hour on 16th Nov. 1944. The functions of the proposed *Board* are: (1) Recommendation as to what portion of yarn available from Indian production should be supplied to Provinces and States interested in handloom industry; (2) assistance to handloom weavers in obtaining dyes, chemicals and other necessary stores at fair price; (3) consideration of the best means of marketing of Indian handloom products; (4) directing research schemes which would be mainly concerned with market research rather than laboratory research, and (5) administration of Government of India's Grant-in-aid. The *Board* was intended to include representatives of Provincial Governments and of the handloom industry, representatives of States and that of mill and yarn trade.

Training in Dehydration Processes

"Two officers of the Food Department have been sent to the United Kingdom to study the methods and processes of dehydration," the Food Member indicated in reply to Mr. H. M. Abdullah in the Assembly on 21st November. "The Food Department," he continued, "had to meet urgent demands from the Defence Services for dehydrated foods and in order to plan new factories and bring existing factories thoroughly up to date, it was necessary to import quickly and temporarily two men with actual factory experience of the latest methods. One of them has been recruited for one year and the other for six months only. Since, however, it was also desirable that we should in future be dependent to the smallest degree possible on experts from outside India, the Department has decided to send two Indian officers to the United Kingdom to investigate modern methods of food technology with special reference to the processes of dehydration and to modern methods of packing. Their experience on return would be of permanent benefit to the Department and to the industry."

Artificial Insemination of Cattle

In answer to a question put by Mr. E. L. C. Gwilt on 21st November in the Assembly, the Health Secretary said that before the Government of India could recommend to Provincial Governments the adoption of the technique of artificial insemination of cattle on a mass scale, it was necessary that experiments should be conducted to modify and adjust the technique to suit Indian conditions. These experiments were in progress at the *Imperial Veterinary Research Institute* under an officer specially trained for this purpose. As soon as the stage was reached when the technique could be adapted to Indian conditions, the question of development would be taken up with Provincial Governments.

ERRATA

1. This *Journal*—Vol. III, October 1944, page 161, left-hand column, line 15—

For Gartside, *et. al.*[3], *read* Gartside, *et. al.*[4].

Page 161, right-hand column—Under references, the following has been omitted by inadvertence.

4 Gartside, Pritchard and Rymill, *Quart. J. Pharm.*, 1938, p. 401.

2. This *Journal*—Vol. III, November 1944, page 204, Table II, entry (*b*), under column 40—

For 0.62 *read* 0.56.

Supplement to

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GIVE SCIENCE A CHANCE*

By SIR SHANTI S. BHATNAGAR, Kt., O.B.E., D.Sc., F.R.S.

Introduction

I AM deeply grateful to the Indian Science Congress Association for the great honour they have conferred upon me by electing me as their President for this year. I had considerable diffidence in accepting this high distinction, particularly as after my election I received an invitation from His Majesty's Government to visit Great Britain, and I was not certain whether I could return from this trip and a subsequent visit to the U.S.A. in time to be able to preside over the annual general meeting in Nagpur in January 1945. I was, however, assured by the Government of India in April last that I would be able to return in good time to preside over the session of the Indian Science Congress, and that I should not refuse an honour which is offered only once in one's lifetime. My colleagues who have been visiting England and the U.S.A. with me advised me to send the presidential address in good time, so that it could be read on my behalf by someone else in case I was unable to reach India in time to preside over the meeting on the 2nd January 1945, and they strongly dissuaded me from resigning the Presidentship. Several happenings, however, particularly the events connected with D-day and the advent of flying bombs and rockets, unfortunately so much delayed our visit to England that it now seems almost certain that I shall not be able to be present with you in body at the time of the general meeting. I shall, however, be present in spirit and I hope under the able management of the local secretaries at Nagpur and the secretaries of the Indian Science Congress Association the session will be celebrated with the usual dignity and keen interest. I am fully aware of the deep interest which His Excellency the Governor of your province has taken in making this session a great success. It is a great disappointment to me that I am unable to take advantage of His Excellency's gracious offer of hospitality during the session.

Before I begin my address I must refer to the sad loss which our country and the world of science has suffered by the passing away of our great Acharya Sir Profulla Chandra Ray. He was President of the session when the Indian Science Congress first met at Nagpur in 1918. Men of his type are not born every day, and our motherland will not easily recover from the shock caused by the death of a son so highly distinguished for his scientific achievements and patriotic services in many fields.

Visit of Professor A. V. Hill

Perhaps the most outstanding event in the scientific life of India during the past year was the visit which Professor A. V. Hill, Nobel Laureate and Secretary of the Royal Society of London, paid to us at the request of the Government of India. The invitation to Professor Hill has been generally taken as an indication of the interest the Government of India is taking in securing the aid of science in problems of national development to which they are committed during the post-war period. It was largely owing to the insistence of the Council of Scientific and Industrial Research that more financial aid should be given to science, that such an invitation could be conceived even during the war. One must not forget, however, the part played by *Science and Culture* which under the able editorship of our distinguished physicist, Professor M. N. Saha, always criticised the Government for lack of interest in matters scientific and for scanty provision of funds.

Several officials in the Government and the public outside thought they detected in this criticism motives of jealousy, as there

* Presidential Address: Indian Science Congress, Nagpur, 2nd January 1945.

is no doubt that the Council of Scientific and Industrial Research had achieved important results in spite of inadequate financial assistance from the Government and industries, and deserved the fullest support from all friends of science and industry. Nothing could be further from the truth than this suspicion. No more ardent supporter of science, and of national development through it, exists in India than Professor Saha and I take this opportunity of acknowledging the help I have always received from him in my lonely fights for better recognition of science in my country. Every form of unofficial support, on which alone one can finally depend for a democratic realization of the role of science in nation-building, always came unhesitatingly from him and his colleagues.

It is a happy augury that the report made by Professor A. V. Hill had an unusually short incubation period. Following his recommendations the Government of India have already created a Department of Planning and Development and the Council of Scientific and Industrial Research has been transferred to this portfolio. Other research activities under the Government are likely to follow suit. I am sure the scientists assembled here have special reason to be happy in the fact that the choice of the Viceroy for the care of this new portfolio has fallen upon Sir Ardeshir Dalal who has been a past-President of the Indian Science Congress and who commands the confidence and respect of the scientists as well as of the business community of India. It is hoped that other far-reaching recommendations of Professor A. V. Hill will also be accepted by the Government of India. There is no better method of raising the standard of science and scientists in this country than that so ably developed and skilfully described in his address before the last session of the Indian Science Congress.

Indian Scientific Mission to U.K., U.S.A. and Canada

Another direct outcome of Professor A. V. Hill's visit to India has been that a mission of scientific workers from our country has been touring the U.K. and has arranged to go over to the U.S.A. and Canada, to observe the scientific, industrial and agricultural developments which have come about in these countries during the war and then to make recommendations and suggest plans for a further interchange of information and knowledge for mutual help and co-operation. India has been cut off intellectually for more than five years from the rest of the world and that in itself is a disaster the magnitude of which is directly proportional to the vast strides science and research have made in the U.K. and North America.

My present visit to England has been the greatest eye-opener to me and I have now seen with my own eyes the high levels to which scientific invention and ingenuity have risen during the war. Not only has science helped in developing weapons and instruments which are essential for success in a mechanical warfare, but it has aided industry and agriculture in supplying the basic needs of humanity during a period of great difficulty. The results both in military and human terms have been most encouraging. The large-scale application of radiolocation, the jet-propelled planes, the numerous types of jettison tanks and unbreakable containers, the automatic weapons of offence and defence and scores of new alloys and novel metallurgical processes have had far-reaching consequences on the course of the war. The technique of operational research, the use of scientific methods of determining tactics and developing a national food policy, the discovery of penicillin and D.D.T., all these have contributed much to the realization by the common man and the Government that organized science is one of the most important factors in national development. It is a tragedy that a ruthless war and almost universal b'oodshed should be necessary for this new awakening, for it should have been obvious without it that science can play and must play an essential part for human advancement. In fact, unless opportunities are provided for science to explore these possibilities for human betterment, a better world cannot be created.

There is no doubt that England is sparing no effort to approach the peace much better informed and equipped than after the last war and the signs of this new awakening are visible in the universities, the Government departments, in industry, the agricultural and medical institutions and in every other walk of life.

As representatives of Indian science, we have been welcome everywhere. The Government, the Royal Society and other learned societies, the universities the Department of Scientific and Industrial Research

and the Research Associations and the National Institutions associated with it, the agricultural and medical institutions, the clubs, the British Council and the industries and trades, the social and political organizations, the public schools and important private individuals have vied with one another to have us for teas, for luncheons and dinners and for speeches for which we have become notorious all over the country! Everyone seems to regard our visit as a prelude to better understanding and trade relationships between our respective countries and as a gesture of friendship from the British Government, British science and British industry to India. Even Ireland has not insisted upon isolation and strict neutrality and I had a most pressing invitation to address the University of Dublin on "Scientific and Industrial Research in India," and this invitation was extended to my opposite number in the U.K., Sir Edward Appleton, as I pleaded that I was tied up with engagements with him and could not visit Ireland unless he also came with me. An important member of His Majesty's Government's Hospitality Department told the Assistant Secretary of the Royal Society that even Kings visiting England did not receive such a warm welcome as the Indian scientists have received ! All this is an indication of the keen interest people in England are taking in science and research.

Science in the British Universities

We found most universities denuded of their ablest workers. They were nearly all engaged in important war work and visited their departments only occasionally. They were busy with meetings and committees and in special scientific work related to the war effort: but all the same they are all devoting their attention to the future of science in British universities. The Association of Scientific Workers has submitted a memorandum to the University Grant Committee of the Treasury suggesting what reforms in teaching and research should be taken in hand immediately after the war and better provision for science should be made in the universities. Their report ends with the following strong plea:

> "We reiterate, then, our plea for the utmost vision and flexibility in budgetting for the development of science in the universities. Where the flowering of intellect is concerned, any accurate prediction is impossible. We are convinced, however, that peace can see at least as rapid a growth in all fields of science as war has brought about in some special applications. The only proper attitude for an enlightened community is to make available the financial and material resources appropriate to each stage of development. We are far from being in sight of either the limits of science or the end of our reserves of intelligence. Bold and flexible thinking is therefore the prime necessity in framing post-war policy for the universities."

Out of the many important recommendations made by the Association of Scientific Workers for the expansion of scientific activities in the universities, the following are quoted so that the Indian universities may take a lesson from what is now the train of thought in Great Britain:

(1) Schools of fundamental research must be fostered in the universities, expansion proceeding as fast as talent appears.

(2) All graduates with an aptitude for research should be offered full maintenance while working for a higher degree.

(3) Research fellowships should be provided for those who have taken a doctorate degree.

(4) When men are appointed mainly to do research they should have to have the same status and salary as those appointed mainly for teaching.

(5) Research committees should be set up in every university to watch over the development of research, especially in borderline subjects, and prepare an annual research budget.

(6) The education and training of laboratory technicians should be given immediate attention. Courses should be planned for general education and technical training.

(7) The wages of technicians must be revised upwards forthwith if the universities are to attract the right type of personnel.

(8) Centralized technical services and supplies for research should be established in each university. These should include facilities such as a typewriting pool and a statistical service.

(9) Departments of applied science should be brought into being, as they are

bound to play an important part in the university.

(10) Industrial development work should be carried out in Research Association laboratories: but where these Research Associations do not exist the university laboratories may be employed.

(11) Academic scientists should be allowed to act as consultants or advisory directors of research to Research Associations and should be given leave to spend long vacations in industrial laboratories.

(12) Properly supervised research in selected Research Associations and Government laboratories should be allowed as part of or a full qualification for a higher degree.

Some of these recommendations involve capital cost and the memorandum referred to above estimates this to be not less than £30 million over a period of ten to twenty years. The actual expenditure of the universities would rise to £15 million per annum within five years and to £20 million over ten years at 1939 values. It has been suggested that most of this money will come from the State. Further, it has been strongly recommended that the Treasury grant to the universities should be doubled in the first academic year after the war and increased to quadruple, that is, to £9 million, in the fifth year.

The future of science in the British universities would thus be assured. This must serve as an incentive to our Vice-Chancellors who should ask the nation and Government for more grants for technical education and developments of sciences in the Indian universities. I have been told that at least in two universities in India, scientific research is now positively discouraged and (in the name of economy) admission to research students, in spite of the willingness of the professors concerned, is almost completely prohibited. I take this opportunity of drawing the attention of those who love their country and wish it well to see that the field of university education is kept as free from narrow communalism and politics as possible. Since politics has begun to play a part in the selection and election of Vice-Chancellors, the university standards in India have tended to deteriorate instead of showing an improvement and if these evils are not looked into by the Chancellors and the courts of the Indian universities, these institutions will cease to be real seats of learning and will turn into arenas for political ambitions.

Science and British Industry

British industry in the past relied too much on tradition. It is now realized that the prosperity of Britain after the war will depend as never before upon the efficiency and progressiveness of her industries. Happily, for it is a most healthy indication of things to come, industrial and scientific research, is on almost everyone's lips nowadays and it is certain that this will be one of the major features in post-war industry. In certain industries, such as the chemical industry, the application of science and research has reached such high levels already that even the Department of Scientific and Industrial Research has not considered it an imperative necessity on their part to equip and maintain their Chemical Research Laboratory to the same level of efficiency as their National Physical Laboratory. They maintain that the Imperial Chemical Industries conduct research on such a large and liberal scale that the Government laboratories need not compete with them. The Directors of the Company are progressive in their views on scientific development and at a luncheon which the I.C.I. gave the Indian Scientists at Claridges, Lord McGowan, the Chairman, reported that the Directors of the Company had offered to provide at nine universities of Great Britain, eighty fellowships of the average value of £600 per annum to be held by senior workers in certain sciences. The research organization of the Company itself consists of nearly nine hundred fully qualified chemists, physicists, biologists, engineers and other scientific men and more than a thousand skilled assistants. During 1943 its expenditure on research and development in its own work was approximately £2,200,000; and in addition, £12,500,000 became due from the Company to the British and Overseas Governments under the heading of excess profits tax, national defence contribution and income-tax. We had the good fortune to see their vast factories and research organizations at Billingham, Blackly and Huddersfield, and our distinguished industrialists who are visiting England should go and see these signs of research-mindedness of the British industries.

When I replied to the toast proposed by Lord McGowan at the luncheon, I spoke of the I.C.I.'s partiality to their own country. They had at least two big factories in India and I pleaded for grants on a generous scale for scholarships for scientific research in India by the I.C.I. I urged that no feast given to the Indian Brahmins is complete without a gift, and that all scientists are Brahmins by profession. The plea went home to Lord McGowan and he promised to consider in a friendly way the question of endowing research fellowships in Indian universities. He also assured us that the eighty fellowships in the British universities were open to Indian scientists in free competition.

Besides the I.C.I., there are other industries in Britain which have large research departments, and we were particularly impressed by the efforts which had been made by such firms as Metropolitan Vickers at Trafford Park, Manchester, by the General Electric Company at Wembley, by Burroughs Welcome, by Brown Firth & Co., by the B.T.H. at Rugby and by the Anglo-Iranian and Shell group organization. In addition to the many private investigations carried out by individual firms, the interests of research by industry are safeguarded by investigations carried out in twenty-four Industrial Research Associations, which are maintained jointly by Industry and the Department of Scientific and Industrial Research.

We are aware of even more outstanding organizations of this kind in the U.S.A. and Canada and look forward with eagerness to visiting the Bell Telephone Laboratories in New York in which the American Telegraph and Telephone Company employ over 4,000 scientific workers and technical men. The General Electric Company at Schenectady, N.Y., the Eastman Kodak Company at Rochester, N.Y., the Mellon Research Institute, Pittsburgh, and the various Petroleum Companies in the U.S.A. have fully equipped laboratories which work day and night on problems of fundamental and applied interests.

If Indian industry has to rise, and rise it must to its proper stature in time, it must begin to devote more attention to expenditure on research. There is hardly any industrial organization in India except Tatas which provides even reasonable facilities for scientific and industrial research. Lately Mr. G. D. Birla and Sir Shri Ram have shown some interest in scientific research, but much has yet to be done by science to save the existing industries in India from extinction by outside competition after the war.

The newly started industrial units of India should join together and form Industrial Research Associations and the Council of Scientific and Industrial Research and the Government should subsidise the organizations so that they may blossom forth into hopeful industries of the future India.

Now that expenditure on research, both capital and recurring, is likely to be free from the excess profits tax, Indian industry should give a real impetus to science. Nothing will help industry and science more than if our firms in India become research-minded. Even before my visit to England I strongly advocated the formation of Research Associations in India and I am glad to hear that the chemical and pharmaceutical industries of India are about to give a lead in this matter and have apprised the Council of Scientific and Industrial Research of their intention to form a research association. After seeing the work of Research Association laboratories here, I have become convinced that we must work hard to get our small and big industries in India research-minded so that they may gain knowledge and strength to produce goods of the best quality and performance.

Industrialization of India Essential for World Progress

Perhaps the most important factor which will have world-wide implications will be our attempt to raise the standard of living in India. Politics does play an important part in all events. It is obvious that the best and quickest way of bringing about national development is for India to have a National Government representative of the people. The present absence, however, of such a Government does not justify that the thinking men and women of India should not devise ways and means of bettering the lot of their fellow-beings to the best of their ability under present circumstances and in view of the future. I am not convinced that the rich and the wise in the land have done all they can for agricultural and industrial development of India.

It has been urged by some that the problem of India is largely biological: that health, food and population are our real bottlenecks. Those who know India intimately are fully aware of the facts that attention to

agriculture alone cannot solve the problem of India's poverty. Biology must be helped by physics, chemistry and engineering, even by mathematics. India cannot be healthy, prosperous and self-respecting, and education, medicine, and agriculture cannot play their important role, unless a good bit of India's population is devoted to pursuits other than agricultural.

In a previous paper I have described the orders of priority for some of the industries essential to India's development. In that paper the first place was given by me to the development of power and there seems to be now a general consensus of opinion that India must develop her hydro-electric and other power resources as her coal resources are already severely strained. This project will have to be largely financed by the State, as it is far too big for any private enterprise in India. The State will also have to help big basic industries and heavy engineering. We should, by all methods of persuasion and even threats, appeal to the existing industries in India to develop the by-products industries associated with them. For example, the great jute industry in India should take immediate steps to manufacture such things as jute boards, Brattice cloth, jute felt from jute waste, jute containers and jute cloth for wearing purposes. The State and the public should insist upon these industries being developed by the jute industry itself. Similarly, it should be the duty of the sugar industry that their by-products such as molasses and bagasse should not be used wastefully as at present. Power alcohol, furfural and its derivatives, acetic acid and all sorts of plastics and solvents can be made from these by-products and these should occupy the immediate attention of the promoters of our sugar industry. They have sufficient money to invest in these ventures which may not start paying dividends all at once, but they will eventually be all very worth-while in national planning and development. If I would not be misunderstood, I would make a suggestion to those European and Indian friends who are interested in the industrialization of India not to fight for less or more to either side, but to come to terms honourable for both and do something to help Indian industry. It is obvious that European friends in India will have to yield to the natural aspirations of India, namely, that industry in India should be largely managed by Indians themselves. Indian businessmen should see that co-operation with the allied powers is the quickest method of developing India. The energy spent in fighting may be better spent in co-operative development. If the by-product industries of coal-distillation, the petroleum industry, the textile industry, the woollen, cotton, sugar and jute industries and the metallurgical and chemical industries are developed, the country will have a different complexion altogether and a co-ordinated programme of development in all directions will become a possibility. This plea I am entitled to make as President of the Indian Science Congress, as I am convinced that science has no future in India unless our agriculture and our industries are fully developed: more food and more health are dependent upon these factors. Scientific and industrial research thrives best when it is applied to material benefit to human kind and to existing industries and existing agricultural enterprise.

* *Cf.* This *Journal*, 1944, 3.

Legislation and Scientific and Technical Progress

We were invited to a luncheon at the House of Commons by Captain L. Plugge, M.P., and were later invited to a meeting by an influential unofficial organization known as the Parliamentary and Scientific Committee. This body consists of a large number of members of both Houses of the British Parliament, together with representatives of many important scientific and technical institutions and societies. It has no official authority but it commands great influence. Its President, Lord Samuel, met us at lunch and its Chairman, Mr. E. W. Salt, M.P., presided over the meeting which we attended. It was a great gathering: Professor A. V. Hill himself, as M.P., introduced the members of the Indian Scientific Mission one by one and each one of us made a short speech on our special subjects. We were subjected to numerous questions of a searching nature and the Chairman assured us that, through their influence in Parliament, they will advocate the cause of scientific and industrial research and development in India. It is my considered opinion that the members of the Council of State and Assembly in India could well form such an organization as the Parliamentary and Scientific Committee. This would keep them in touch with all the problems of modern interest such as technology, science, agriculture, food and health.

They could help by talking over matters with Honourable Members privately or by asking questions on the floors of the two Houses. Such an organization would enable our legislators to take an intelligent interest in the terrific task of reconstruction which faces our country. This would also lead them to appreciate the special role of scientific men in modern society.

Training of Personnel

As a result of our visit it may be possible to persuade the Government to have scientific liaison offices in Washington and London, and possibly Moscow, so that the Indian scientists and the Indian Government departments may be in touch with the rapid strides which science and technology are making in these countries. These offices will have to be staffed by scientific men of some standing in India. It is also likely that we may be able to get admission for a large number of scholars and technicians from India both in the universities and industries. We found many universities eager to have good students for post-graduate studies. Lord Eustace Percy was particularly anxious that good class Indian students should take advantage of medical and dental studies in their well-equipped faculty of medicine at Newcastle. Similar assurances were given to us by the authorities of Cambridge, Oxford, London, Sheffield, Leeds, Glasgow and Manchester Universities. There will be a great paucity of space immediately after the war in these places of learning, but they hope to have a great deal more space later on. We should increase the availability of technical talent in India by sending our young and brilliant students to England and America. India needs not only scientific researchers but also technicians—persons of the foreman type who can help in the running and repairs of machinery so essential for industrialization. Such firms as the Imperial Chemical Industries, Metropolitan Vickers and the non-ferrous metal industries in England are quite willing to train young men from India and even pay them as apprentices: we need a very large number of men with these qualifications, and we shall have to look for such training in Canada and the U.S.A. as well.

Factory and Farm

In England great emphasis is being laid on equalizing the standard of life in the cities and the villages. Agriculture still retains in England too much of its primitive character. Modern methods of application of energy on the farms, conditioned transport and proper storage of agricultural produce are still in their infancy. Canada and the United States are ahead in this field and the tractor, the motor vehicle and electric power have contributed a great deal in those countries for a better standard of life on the farm. On a value basis at present about 88 per cent. of the world's agricultural produce is used as food, 8 per cent. as textiles and 4 per cent. for other industrial purposes. The last two together form roughly one-third of the raw materials of industry. There is an increasing tendency to look to agriculture for a larger proportion of these raw materials, but these materials can only be used profitably if the factory becomes an adjunct of the farm.

After studying the great strides which science has made in England, we are expecting to visit the U.S.A. and Canada. As a young boy, my class-mates used to tease me for being a day-dreamer. I used to think of great things which science could do for India and the part I, myself, should play in it with the rest of my friends. The improbabilities of my dreams coming true used to be the principal subject of jokes when I was a student. If I had not possessed a sense of humour and had taken those jests seriously I should have been a physical wreck. But, God be thanked, I have survived to see some of my dreams fulfilled. Failures have been many and successes rather few, but with an inborn optimism and faith in my country's future I pursue on. We shall now go from Billingham, Leeds, Sheffield, Coventry, Lancashire, from the Royal Society of London and from our beloved Hill and Dale to the lands of Niagara Falls, the Boulder Dam and the Tennessee Valley. The tale of the Tennessee Valley is the romance of a wandering and inconsistent river, now become a chain of charming and lovely lakes which have contributed much to the enjoyment of life of the people, on which move, without any dangers of accidents, barges of commerce which nourish American industries. It is a fairy story of wild waters controlled by human ingenuity creating electrical energy which has been America's Alladin's lamp.

I dream of the Tennessee Valley, but not without hope: for all this may happen to any river valley in India, to the Damodar, to the Ganges, to the Sutlej, to the Nurbedda, to the Sone, if the people and the Government just give science a chance.

INDIAN PATENTS

[The following is a list of Patent Applications notified as accepted in the *Gazette of India*, Part II—Section I, for the period November 1944. Patents from the *Council of Scientific and Industrial Research* are indicated by an asterisk.*]

31227. DAVY AND UNITED ENGINEERING CO., LTD. Improvements in or relating to hydraulic presses.

31257. SOCIETY OF CHEMICAL INDUSTRY IN BASLE. Hydroxy Hydrophenanthrene carboxylic acids, their derivatives and process for making same.

31258. AUTOMATIC TELEPHONE AND ELECTRIC CO., LTD. Improvements in electric switches.

31269. PHILIPS LAMPS, LTD. Improvements in and relating to tuning mechanisms for wireless sets.

31272. R. D. MASON AND A. C. JUSTESEN. Improvements in the manufacture of a cream substitute.

31287. MASONITE CORPORATION. Improvement in carbon.

31288. ELECTROLUX, PTY., LTD. Improved kerosene burner for use in refrigerators or in other heat actuated apparatus.

31585. STANDARD TELEPHONES AND CABLES, LTD. Electrical calculating apparatus.

31598. THE FINE COTTON SPINNERS' AND DOUBLERS' ASSOCIATION, LTD. and BLEACHERS' ASSOCIATION, LTD. Improvements in and relating to rope.

30169. B. E. WEERASINGH. Writing apparatus.

30181. TECALEMIT LTD. Improvements in or relating to spring loaded non-return valves more particularly for use in lubricant or like receiving nipples.

30187. VOKES LTD. Filters for gases under pressure.

30315. W. T. HENLEY'S TELEGRAPH WORKS CO., LTD. Improvements relating to electric cartridge fuses.

30371. PRESSOTURN LTD. and C. G. MANCHA-BENNETT. Improvements in nuts.

30575. DUNLOP RUBBER CO., LTD. Improvements in and relating to belting and the manufacture thereof.

30607. P. G. MENON. Improvements in or relating to spanners.

30847. MILES AIRCRAFT LTD. Improvements in press release fastening devices.

30928. RAI BAHADUR HARJIMAL BASHESHAR NATH KHANNA AND SONS. A composition block and method of making same.

31030. B. B. PRASHAD. Producer-gas plant for internal combustion engines.

31088. HELLIWELLS LTD. and J. RANSOM. An improved method and means for shaping sheet metal under pressure.

31128. W. M. WELSFORD. Improvements in nails, rivets, staples and like pointed fastening articles.

31131. AMERICAN STEEL FOUNDRIES. Improvements in or relating to railway car trucks.

31141. S. NARAYANAN. Automatic spinning machine.

31152. E. N. CONTRACTOR. Improvements in or relating to billiard cues.

31256. R. J. KENNY. Improvements in or relating to apparatus for cooling or conditioning air or other fluids.

31263. G. AHMED. An improved key ring.

31265. HARRISONS AND CROSFIELD, LTD. Improvements in mangles.

31278. BRITISH ROPES LTD. Improvements in and relating to locked coil ropes.

*31284. DR. M. QURESHI and T. V. SUBBA RAO. Varnish from castor oil products.

31305. J. L. BURTON AND A. E. PERKINS. Pocket lighter.

31312. STANDARD TELEPHONES AND CABLES LTD. Improvements in or relating to electro-acoustical transducers.

31313. STANDARD TELEPHONES AND CABLES LTD. Improvements in or relating to electro signalling system.

31318. AMERICAN CYANAMID CO. Improvements in or relating to beneficiation of oxidized iron ores by froth flotation.

29783. IMPERIAL CHEMICAL INDUSTRIES, LTD. Improvements in or relating to liquid fuel containers.

29827. L. R. SIMMONS. Improvements in or relating to hauling units or structures.

29881. J. J. CURTIS. An improved self-closing water tap.

30190. F. M. ASPIN. Improvements in or relating to thrust bearings for rotary valves.

30205. IMPERIAL CHEMICAL INDUSTRIES, LTD. Improvements in or relating to the hardening or insolubilisation of artificial filaments obtained from protein solutions.

30208. IMPERIAL CHEMICAL INDUSTRIES, LTD. New anthraquinone dyes.

30209. G. H. CHEESMAN. Improvements in or relating to the manufacture of concrete articles by extrusion.

30217. R. A. LISTER & CO., LTD. Improvements in or relating to sleeve-valve engines.

30250. HOFFMANN-LA ROCHE, INC. Improvements in or relating to the production of esters of the isoascorbic acid series.

30262. THE WELLCOME FOUNDATION, LTD. Improvements in and relating to the manufacture of derivatives of 4: 4-diaminodiphenylsulphone.

30277. A. H. HUNT, LTD. Improvements in or relating to processes for the treatment of metallised paper and the manufacture of electric condensers therefrom.

30310. T. I. (GROUP SERVICES), LTD. Improvements relating to draw bench dogs.

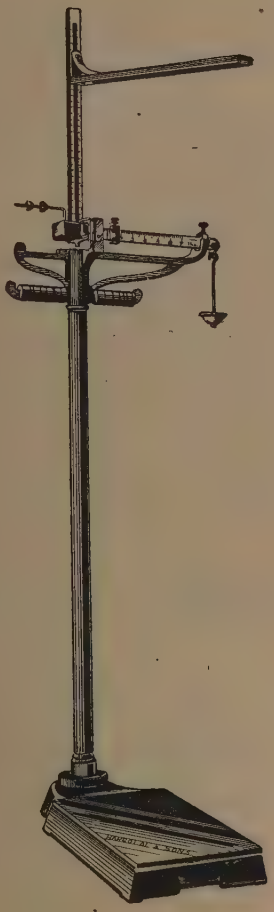
30381. MARCONI'S WIRELESS TELEGRAPH CO., LTD. Improvements in frequency discriminator electric circuits.

30385. L. SATCHWELL. Improvements in electric resistance grids.

30389. THE METAFILTRATION CO., LTD. and J. A. PICKARD. Improvements in and relating to filters.

30423. MARCONI'S WIRELESS TELEGRAPH CO., LTD. Cathodes for electron discharge devices.

30442. MARCONI'S WIRELESS TELEGRAPH CO., LTD. Phasing device for synchronous telegraph system.



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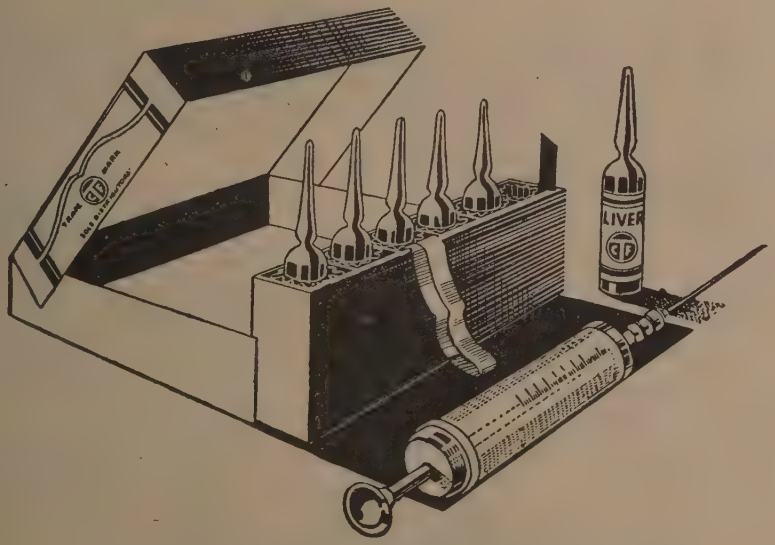

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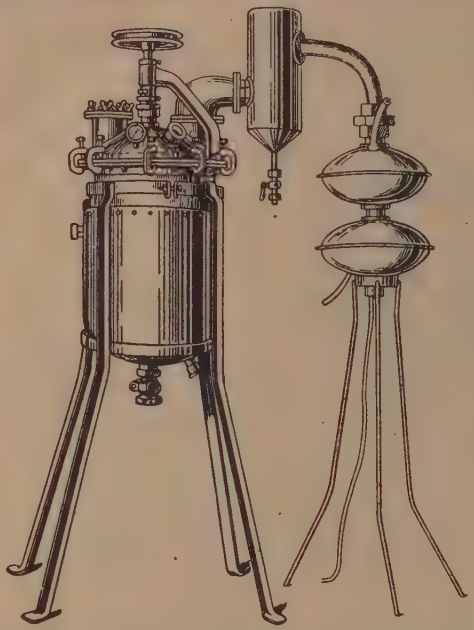

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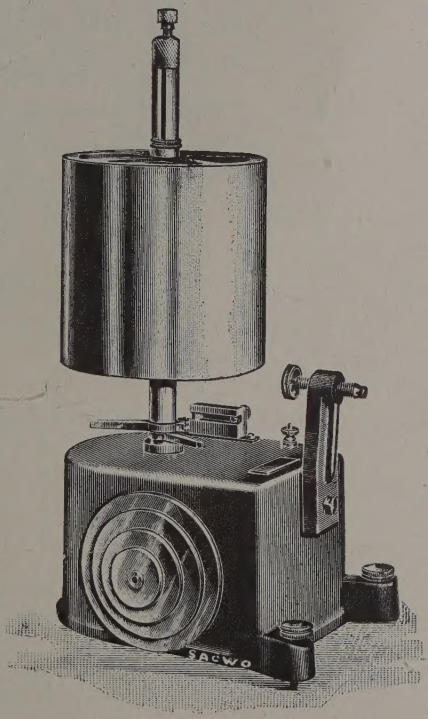

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